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THE NEWER TYPE OF MATHEMATICS COMPARED WITH THE OLD*

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Many types of mathematics have been suggested in recent years. For this reason, it may be well at the outset to explain what I mean by the old and the new mathematics. As a rough classification, we may take:

1. Compartment Mathematics
2. General Mathematics
3. Integrated Mathematics

The compartment type is the kind of mathematics most of us studied in our own school days. It is still used in most schools in the United States.

The General Mathematics was introduced about 25 or more years ago in the schools of this country for weak pupils unable to master the compartment type of mathematics. The very reason for its introduction gave it a bad name, and most colleges and universities refuse to accept it for admission and still demand the compartment type for entrance.

It was this bad repute of General Mathematics which led the speaker to introduce the term Integrated Mathematics. It is not intended for weak pupils, but at the same time it calls for no more ability than the Compartment Mathematics. It is like the General Mathematics in that it does away with the compartments, but that is the only thing it has in common with General

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Mathematics. General Mathematics has a little simple algebra, then a little measurement or intuitive geometry, then a little more algebra, and so on. It is somewhat like a layer cake. Integrated Mathematics on the other hand has organized the different branches of mathematics into a logical whole. The pupil begins logical reasoning and draws conclusions from the beginning. He puts most of his statements in the "if-then" form. There is no such shock at any stage as that which is usually received by the pupil when he begins geometry after a year of manipulative algebra.

Integrated Mathematics develops basic skills in connection with advanced topics rather than by rehearsing old material. This may be said to be one of the most important characteristics of Integrated Mathematics. How this is done, I shall explain in more detail this afternoon.

Integrated Mathematics emphasizes the idea that it is the function of mathematics to help the pupil understand the world in which he lives. As its name implies, it preserves the unity of mathematics and its application by emphasizing not only the relation of the various branches of mathematics to each other, but also their application to related fields in other subjects. Application is made to business, statistics, life insurance, installment buying, small loans, music, economics and science.

To find time for these applications, use is made of the principle that proper emphasis on concept and understanding reduces the amount of drill needed. From the outset, correct mathematical concepts are introduced so the pupil has nothing to unlearn later. Contacts are made with more advanced topics in a simple and natural way, thus bridging the gap between the college and the secondary school.

The chief difficulty with this new type of mathematics is the teacher and not the pupil; and the difficulties are increasing instead of decreasing. In the East, the Teachers Colleges dominate the teacher-training situation to such an extent that they have gone to the state capitals and secured legislation demanding so much pedagogical training, that the future teachers have no time left in which to receive adequate instruction in their special subjects. As the teachers find it nice and pleasant to indulge in soft pedagogy, they say nothing and submit meekly to all kinds of educational tyranny such as state adoption of textbooks and other domination by politicians. About two years ago I visited the School of Advanced Studies at Princeton. One

member of the party asked the head of the school what he considered the outstanding feature of Princeton as an institution of higher learning. He replied: Princeton has no school of education.

In this connection, it is only fair to mention that many professors in teachers colleges are very strong for subject matter, but unfortunately they are in the minority. Others say that they believe in subject matter, but do not act as if they did. For example, some teacher-training institutions offer courses in pure mathematics but make them elective, and thus allow a great number of the weaker students to escape being subjected to them. The failure of the college professors in pure mathematics to help out with the training of secondary teachers is another serious matter. Apparently they think it is beneath their dignity.

Another difficulty with the old type mathematics and Elementary Algebra in particular, is that the pupils are not taught the fundamental laws of the subject. Just think of attempting to run an organization without by-laws. Yet this is exactly what is done in mathematics. The pupils are not taught the laws which underlie the subject and just guess. For this reason, they have only a fifty-fifty chance of being right. For example, how many pupils know that in $6x/2$ the division is non-distributive while in $(6+x)/2$ the division is distributive. This leads to the so-called cancellation of terms and many other evils.

A recent examination in New York City given to several hundred college graduates who had specialized in mathematics showed that this ignorance of the fundamental laws is shared by many future teachers of mathematics.

As I see it, the mathematics curriculum in the secondary schools of the United States is defective in three fundamental aspects:

1. concepts
2. time-distribution
3. continuity

There is nothing harder for an American to understand than why time is such an important factor in the learning of any subject. He can not understand why elementary algebra can not be finished in the ninth year, or why a one-year exposure to calculus in the sophomore year in college does not give a thorough mastery. By spreading algebra, geometry, trigonometry, analytical geometry, calculus, statistics, etc. over the entire

time that a student devotes to mathematics in high school, a much longer time exposure is secured in each subject. This means a better background and retention in mathematics as a whole, and that the student is taught mathematics the way he will meet it in life.

Time forbids much of an analysis of the whole situation, but the best evidence of the lack of continuity in the mathematics instruction in high school is found in intermediate algebra. In the eleventh year, most of the textbooks in use begin algebra all over again, not in a more mature way than elementary algebra but in the same reckless disregard of fundamental laws and operations of the subject. Also the demonstrative work of the tenth year, the pride of the old style mathematics, is thrown to the winds; and no logical reasoning or applications, except perhaps the obvious ones of the rectangle and the square, are taken up in the eleventh year. The word locus is not even mentioned.

In addition to remedying these defects, the newer mathematics concerns itself with topics which lead to the mathematics of social science, since science no longer means merely physical science. Many an educator has found to his sorrow that the old mathematics did not help him in statistical work, and much of his present opposition to mathematics is no doubt due to this fact. But instead of examining the new mathematics to see how this defect has been remedied, he condemns all mathematics as being equally useless. Nor does he seem to realize that it is not the subject which is at fault, but rather the poor selection of topics and the way these topics are taught.

Some of the recent changes in mathematics have their origin in recommendations made by the International Congress, held in Rome in 1908, namely that the function concept be made the unifying element of all mathematics and that it lead to an introduction of calculus and statistics in the twelfth year. This program was immediately adopted by all the leading countries in Europe. A description of the curricula for the different countries is found in the *Fourth Year Book of the National Council of the Teachers of Mathematics*. But the United States was not ready for this ambitious program.

The three American commissioners: David Eugene Smith of Columbia, William F. Osgood of Harvard, and J. W. A. Young of Chicago showed on their return that the secondary pupils in this country were two years behind the pupils of other leading

countries in mathematical attainments. Hence it was realized that something had to be done. The Mathematical Association of America was organized in 1916, and its first president, Professor Earle Raymond Hedrick, appointed the now famous National Committee to plan a reorganization of mathematics for junior and senior high schools. The Report of the National Committee, stressing the function concept as recommended by the above mentioned International Congress, appeared in 1923, and the College Entrance Board immediately appointed a committee to study this report. In spite of the fact that the most influential members of the National Committee were also members of the Committee of the College Entrance Board, the recommendations in regard to calculus and statistics were not accepted. The reason being, as stated by the President of the National Committee, J. W. Young of Dartmouth, the teachers were not as yet trained to teach these subjects.

In 1931 the Regents of the State of New York began to revise its syllabi in mathematics. The ninth and tenth years remained the old type of separate algebra and geometry. The eleventh year syllabus combined intermediate algebra and trigonometry.

The twelfth year, as originally planned, was to be a comprehensive syllabus in advanced algebra, elementary calculus and analytics, statistics, and solid geometry. But before this syllabus was finished, some reactionary influence set in and the committee was dismissed. A syllabus combining advanced algebra, some analytics and calculus, and statistics was issued for one half of the twelfth year, but solid geometry of the old type remains even to this day and occupies the other half of the twelfth year.

During the years 1934–1936, a committee for the College Entrance Board was at work. This committee recommended that the separate examinations in algebra, geometry, trigonometry, advanced algebra, and solid geometry be replaced by comprehensive examinations known as Alpha (two years), Beta (three years), and Gamma (four years). These examinations are now in effect. They have met with some opposition, particularly in conservative New England, but they seem to be here to stay.

At present another National Committee under the auspices of the National Council of the Teachers of Mathematics is at work from which a report is expected in 1938. We hope that the recommendations of this committee will be progressive and

help to give mathematics its proper place in the modern secondary curriculum.

From the above, it is evident that the tendency in the teaching of mathematics during the part of the present century already spent has been somewhat away from the manipulative and the mechanical side to a saner and more useful kind of mathematics which can help the pupil to a better understanding of the modern world.

MEASURING DIAMETER AND DISTANCE OF SUN

By Bruce Erickson and Le Roy Leadholm
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The following experiment on the distance and apparent diameter of the sun was performed under the supervision of Professor C. G. Stratton of the Geography department at River Falls State Teachers College.

The apparatus used consisted of a long cardboard tube, a pair of dividers, and a draftsman's rule. The tube was covered at one end with tin foil and at the other end with semi-transparent paper. A pin hole was made in the tin foil allowing light to pass through and form an image on the semi-transparent paper. With the aid of a pair of dividers and a draftsman's rule we were able to determine the size of the image. By measuring in 60ths. 40ths., and 32nds of an inch, and taking the average of these we were able to reduce the probable error and obtain the size in thousandths of an inch. The tube was 102.75 inches long.

On October 26 the first measurement was made. The size of the image formed was .965 inches. Considering the diameter of the sun to be 864,100 miles, and solving for the distance by the principle of similar triangles, we used the following formula:

$$\frac{.965}{102.75} = \frac{864.100}{X}$$

We found the distance to the sun to be 92,006,503 miles. Using the same figures we also determined the semi diameter of the sun in minutes of arc. With the following formula we calculated the semi diameter of the sun.

$$\frac{.965}{2} \div 102.75 = \text{Tan. } X$$

The Tangent of angle X was .00469 and by use of a table of tangents we found the angle to be $16'.13$.

We performed the same experiment on November 22. This time we found the diameter of the image to be .97 of an inch. Increase in the size of the image was due to the fact that we were getting nearer to the sun. Using the same formulae as above we found the distance to be 91,532,345 miles, and the semi diameter to be $16'.23$.

According to the *Nautical Almanac* the semi diameter of the sun on October 26 was $16'.12$, and on November 22 it was $16'.22$. This showed that we made an error of only $.01'$ in each instance.

The results which we obtained show that accurate measurements can be made without the help of expensive instruments.

JAMES H. SMITH

James H. Smith of Chicago, for many years assistant principal of Austin High School, died at his home on Thursday, Dec. 2, 1937.

Mr. Smith was president of the Central Association of Science and Mathematics Teachers during the two consecutive years of 1909 and 1910. He was a familiar figure at every meeting for a great many years and hundreds of the members valued his friendship and help. He was always willing to give support to whatever project the Association undertook.

Mr. Smith was born in Massillon, Ohio, in 1862. He attended Oberlin College, the University of Michigan, Johns Hopkins University, and the University of Chicago. In 1900 he became a physical geography teacher at Austin High School. In 1911 he became assistant principal of the high school and in 1916 he was made principal of the night school. He was active in both of these positions until his retirement in 1932.

HAROLD H. METCALF, *Secretary*

SCIENCE CONGRESS OF THE AMERICAN INSTITUTE SCHOOL SCIENCE CLUB

More than fifteen hundred junior and senior high school students participated in the sessions of the Science Congress of the American Institute School Science Clubs, at the American Museum of Natural History on Saturday, December 18. Members of 139 School Science Clubs assembled from Greater New York, New Jersey, Long Island and Westchester for this annual get-together, to demonstrate and describe their after-school scientific pursuits, and to exchange views on their scientific hobbies.

The Science Congress comprises a series of meetings on various phases of science. The students give talks and demonstrations of their work in the clubs. Boys and girls act as chairmen of these meetings, and the audience is made up of boys and girls who are members of the Clubs, and who enter into discussions with the speakers following the talks and demonstrations.

The Science Congress is one of the important events of the American Institute's work for school children. In addition, it presents the annual Christmas Lectures held each year during the Holidays. And the climax of the school science year comes with the annual Science Fair in May, at which prizes are awarded for exhibits designed and displayed by the students. This Fair, now widely copied in other urban communities, replaces the county fairs of many regions and similarly receives State support.

Fifty-four high school students, representing twenty-nine School Science Clubs, presented the program of the Science Congress under nine subject divisions: Electro-Magnetic Waves, Micro-Biology, Atomic and Molecular Physics, General Physics, Chemistry, Light, Animals, Junior Biology and Physics, and Junior Astronomy.

SOME OBJECTIVE STANDARDS OF A GOOD TEACHER

By John R. Sampey
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Under the present educational system in institutions of higher learning in the United States the research professor has such an advantage over the teacher that the latter has in many instances, consciously or unconsciously, developed an inferiority complex. Not only are his advances in academic rank slower, but often he has appended the odious title of "Collegiate Professor." There are many causes contributary to this unhappy situation, but ultimately most of them may be traced to the fact that the research worker has evolved a set of well defined tests or standards by which the quality of his work may be determined objectively, while his teaching colleague has practically no criteria upon which he, or anyone else, can rely for a fair appraisement of his efforts. As long as this situation continues, the man who can marshal acceptable credits is going to continue to be more favored, however unfairly the system may work.

The situation in the university finds its counter-part in the American college. The instructor who devotes all his time and energy to his teaching finds himself after a decade or more of conscious effort, on practically the same level professionally as his colleague who may never give his teaching a thought from one recitation period to the next. If his ambitious soul rebels against such inequality, he may discover that the way to gain favor with the college administration is to offer a helping hand in the dean's office, the registrar's office, or the headquarters of the legion of student activities. A few hours a day of clerical duty in the former, or the engineering of a successful "stunt" in the latter will bring far more recognition than many times the same effort spent on his main task.

Neither the university nor the college teacher can expect much assistance from existing crediting agencies. While the teachers in the secondary schools have made a beginning toward receiving rewards for advanced degrees, summer school credits, seniority rights, and other forms of special recognition, the standardizing agencies among the colleges and universities stop with the requirement that the head of a department must have the Doctor of Philosophy degree, or its equivalent. After

a man attains to this stature he may go to seed professionally, but he retains his life certificate as a teacher.

If there is to be no help from outside sources, what standards can the teacher work out for himself? If he is left to initiate the tests, it is imperative that they be of an objective nature. Is it possible to erect any objective standards of success in teaching? If such is possible, then the teacher can hope eventually to gain recognition for his efforts only to the extent that there is agreement upon the validity of the standards erected.

Will any of the tests which the research scientist has evolved so successfully to judge the merit of his work apply to the teacher? Publications in the technical journals of his own field furnish the research man with the chief outlet for his genius. The editing and reviewing boards of most of these publications hold the authors of manuscripts to such exact standards, that the acceptance of an article carries a distinct honor. In contrast, how difficult it is for journals in the field of education to formulate a code that will bring similar distinction to the teacher-author. All too often they rely upon the official position of the author, rather than upon the merit of the manuscript, to determine its fate.

The writing of monographs and textbooks are other forms of publication with which the specialist enhances his reputation. These are open to the teacher also as objective tests of his methods, but unfortunately, because of the financial risk involved, they are of limited value. We may observe in passing, however, that while relatively few teachers will succeed in persuading a publisher to sign a contract, that every instructor who strives for originality in his teaching should be at work on a manuscript, which though it never get beyond the mimeographed or lithoprinted stage, will serve to stimulate him and his classes as few other teaching devices.

The other forms of recognition that come to the research man seldom are bestowed upon the teacher. Among these may be mentioned invitations to take part in symposia at national meetings of learned societies, election to one of the national offices of the same, exchange professorships or lectureships, consulting work for industrial and commercial concerns, and medal awards.

If the methods and means of both accrediting agencies and research organizations fail to provide standards of excellence for the university and college teacher, what may he work out

for himself? We shall name only four tests in the hope that there may be some agreement upon their validity, and upon what is more important still, the definiteness with which each may be tested objectively.

The first test centers around the qualifications of the teacher as a productive scholar. There is opposition in some quarters to the Ph.D. as a teaching degree, and more yet may be found to the idea that the teacher should himself continue to use the tools of research he learned to handle in acquiring the said degree. Such critics, however, have in mind more the duties of a kindergarten attendant than those of a teacher at the college level. It may not be true of the teacher in every field, but in the physical sciences at least, the instructor who fails to keep alive the spark of creative scholarship soon becomes a peddler of other people's wares, and ere long he discovers he has lost that vitalizing first-hand contact with the great mysteries of nature, which constitutes the first essential of the scientist, be he teacher or investigator.

There are few difficulties in evaluating the teacher as a productive scholar, for the same criteria of success apply to him as to the research specialist. While the teacher's productive output cannot be measured in mass with that of the man giving full time to this enterprise, in its more limited sphere, it should be as clear cut in its analysis of a problem, and as direct and original in its solution. To the time worn excuses of limited library and laboratory facilities, there are portions of the summer months, not to mention years of Sabbatical leave, in which to make up the former deficiency, and there will always remain more than enough fundamental problems in the physical sciences to keep the teacher in the smaller college at work, however limited his laboratory means.

In addition to the publication of an occasional research article, the teacher may check on his standing as a scholar by examining the extent to which he reads his own professional journals, and on how frequently he attends the national meetings of his society. State academies and local sections offer more frequent contacts, but the programs are less stimulating.

The second standard aims to determine the extent to which the teacher carries the scientific method and attitude into the classroom and laboratory section. Each lesson should be approached critically as to content and method of presentation. There is no place here for wornout lecture notes or routine

laboratory procedures, threadbare in content and stale in humor. It may be taken as a working hypothesis on every assignment that the best method of presentation has not been worked out. In all these experiments every effort should be made to discover what are the variables in the situation, and then how the same may be controlled. No less important are the working out of methods of checking on results, and the recording of the same. The field presents unlimited opportunities for new discoveries, and the progressive teacher can accumulate abundant material for texts or journal articles on methods, lecture demonstrations, and laboratory procedures. Improved performance on the part of the student may be detected as surely and as promptly as the research worker may note progress in a laboratory problem. The teacher has one advantage over the latter in this connection, for while no one may ever repeat the preparation of a rare compound described in a technical journal, the teacher may witness the immediate progress of a number of students through the improvement of a method or a procedure.

The above discussion leads to the third test, which is to discover as objectively as possible student response. This is not to be limited to the hearing of daily recitations or the tabulating of grades on quizzes, tests, and examinations, although the recent growth of coöperative tests on a nation-wide scale increases the objective nature of the age-old process of giving examinations. Nor is this standard to be interpreted as judging one's success as a teacher by the size of one's classes, for on most campuses the most popular professors are usually the biggest showmen, and almost without exception, they demand little from the student. In seeking to determine student response, it is essential that the classes or sections be small, for in all real teaching there is no escape from the personal contact of instructor and pupil. The instructor must know something of the past and present environment of the student if he is to use the most effective method of presentation. Equally significant is a knowledge of the use to which the student expects to put his training, for if he is in the course for its cultural value, he cannot be expected to submit to the same drill on the technicalities as one who is training for the field in a professional manner. Only when the instructor is informed on all these personal items can he hope to evaluate the student's response.

There is a more objective way of checking on student response, but it requires considerably more time. The instructor,

however, who never follows his students after graduation can claim to have only a partial check on the results of his teaching. If a fair percentage of his students majoring in the department do not go through graduate school creditably and make a success in their professional life, the instructor should ask himself to what extent he is to share the responsibility of their failure to measure up to the highest standards. And what of the far larger group who take only one year in the department? The instructor who has the temerity to seek an objective test on this part of his teaching may well prepare himself for the worst, for alumni are more outspoken on such matters than undergraduates still in the grind.

In setting up a sense of community responsibility as the fourth standard of a good teacher we are on controversial ground. Many believe the professional activities of the teacher should be bounded by the limits of the campus, and they point a cynical finger at the failures some of the brain-trusters proved when they assumed roles of leadership in the practical affairs of life. For this group the cap and gown of the hermit of mediaeval time is the most fitting badge of service.

On the other hand, there is a growing body of educators who feel the unprecedented call for community leaders, a challenge for the teacher to contribute his part. Surely the call was never more urgent or the opportunities for service more numerous. Shall the teacher continue to limit his technical knowledge to the language of pure science, his love of culture to college museums and libraries, and his habits of straight thinking to academic problems? To do so will be to invite to our shores those movements of narrow nationalism that have stifled the joy of courageous living from more than one center of European culture.

In reviewing these four standards of a good teacher we are impressed not only with the difficulties of finding objective tests for the same, but we face the more discouraging fact that it is well-nigh humanly impossible for a single individual to be endowed with the qualities of mind and heart to meet the requirements under the present system. The very multiplicity of the demands made upon the teacher proves his undoing in this age of specialization. To enumerate again, we see he must be a scholar in his own right, a master of the difficult art of teaching, an inspirer of youth, and a leader in the large field of community service. His chief competitor, the research man, on the

other hand, needs only intellectual brilliance to insure his success under the present system. Society will have to recognize, if not create, new values before the teacher receives his due. Only then can he hope either to erect or to measure up to the tests that will in any objective way evaluate his labors. And the teacher must himself be the creator and preserver of the new order.

BLACK HILLS SCIENCE CLUB HAS OUT OF STATE MEETINGS

By Clara M. Roberts

Secretary-Treasurer, Rapid City, South Dakota

The October meeting of the Black Hills Science Club was held at Devils Tower, Wyoming. Approximately 28,800 persons have visited this outstanding scenic attraction during the summer of 1937. The Tower is only a few miles off the highway to the Yellowstone National Park.

Newell F. Joyner, custodian, led a group of fifty club members on a lecture tour about the base of the tower. This giant column of phonolite porphory, granite-like rock, stands 868 feet above its base and 1,300 feet above the surrounding prairie.

The tower was scaled last June. The first ascent was made in 1893 by Will Rogers, then a Wyoming rancher.

Fossil quarries at Agate, Nebraska were visited by the club at their November meeting.

The beds consist of three buttes leased by prominent universities, from whom permission to dig for fossils may be obtained. Harvard University, Princeton University, and The University of Nebraska each own a hill.

These fossils were buried by streams of the Tertiary period (almost a million years ago). Here are found remains of the fossil horse. The fossils represent stages in the development of the five-toed horse to the four- and three-toed horse. Practically all species of the early elephants are found here also. The shovel tusk elephant is of particular interest. Harvard museum and Morrell Hall museum in Lincoln have complete skeletons of a giant hog, *Archaeotheriumingens,* taken from the Agate fossil beds. A large extinct horse-like animal, *Moropus,* had knife-like claws instead of hoofs. The fossil ancestors of the present camel are found in great numbers in the Agate beds. All species except those that migrated to central Europe, Asia or Africa have become extinct.

All the above fossil remains are to be found in many museums, but especially valuable collections appear at Harvard and Princeton, and in the Museum of Natural History in New York. A local museum operated by Captain James Cook is arranged in two large rooms in the ranch house. It contains many valuable fossils.

CRATERS

Pits in the earth of Esthonia, like the great meteor crater of Arizona but smaller and shallower, really are meteor craters, Dr. Clyde Fisher, director of the Hayden Planetarium reports. Doubts as to their nature were resolved when Esthonian engineers found fragments of meteoric iron buried in and near their rims.

ELEMENTARY SCIENCE TEACHING

By Philip B. Sharpe
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The primary object of education is, of course, to make our children more successful in growing up and assuming the responsibilities of adult life; just as the training given by any animal to its young is to make them more successful in growing up and bearing the burdens of adult life.

There is this difference, however, that while the education of the wolf or fox is primarily athletic and strategic and can be pretty completely learned in puppyhood, the education of man is primarily social and mental, unlimited and unending, and only the basic technique of learning can be mastered in childhood. Therefore certain fundamental parts of education, certain necessary skills of learning, have long been recognized as of fundamentally the greatest importance. I refer to "the three R's."

Of greatest importance is Reading, because if one can read he can learn from books,—the most rapid method of acquiring information ever invented. Of great importance also is Writing because writing aids in clarifying and communicating thought. Arithmetic allows one to handle problems in an exact and quantitative manner.

To this list of the three R's, I should like to add a fourth R, Research. Skill in Research enables one to go to the sources of knowledge: library facilities, the works of specialists (I use the word in the broader meaning), and, most important of all from my point of view, Science.

Science is two things: a method of solving problems, and the accumulated solutions of past investigations. The common definition found in so many texts, "Science is organized knowledge," is faulty in that it applies equally well to the dictionary itself. It is a definition that does not define sufficiently.

Of these two aspects of Science, the scientific method of solving problems is more basic and so more important than the accumulated solutions of the past. Given just the method, the solutions we have today could be quickly rediscovered, and the billions more that await us in the future would not be closed off from us as would be the case if we were given only the accumulated discoveries of the past. To neglect the scientific

method is to neglect scientific progress and the core of the subject.

To the individual student as well as to the human race, the scientific method is more valuable than the handful of rote scientific facts which he may receive in school and which slips so quickly through his fingers. He will receive the main benefits of scientific knowledge outside of school whether he acquires much scientific knowledge or not. But if he acquires the scientific method in school, he too can become a discoverer and inventor on some scale, he can solve many personal problems, he can face custom, superstition and propaganda with intelligence, he can appreciate and comprehend the scientific age in which he lives.

Furthermore, the scientific method becomes a mental habit and skill; and, like swimming and other skills, once acquired, it is never largely forgotten. In so far as we teach Reading successfully we make readers; in so far as we teach Writing successfully we make writers; in so far as we teach Arithmetic successfully we make figurers; in so far as we teach Science successfully we make scientists.

Our plain duty as science teachers is primarily not the teaching of a quantity of scientific facts, but the giving of scientific training. Science teachers in Senior High Schools are compelled to give mostly factual information to prepare their students for college entrance examinations which are chiefly factual in nature. Grade and District teachers are not under that necessity. Your students take no science examinations that matter. Yours is the freedom either to bog down in the old routine and teach mere facts, or, to use facts as a means of giving your students vital training in scientific method and to use the scientific method as the chief method of finding the facts. Use the facts to develop the method and the method to develop the facts.

Most of you here have taken very little so-called science, you didn't care much for what little you took, and you have forgotten practically all of the little collection of facts you did assimilate. But, believe it or not, I am glad of it. The more heartily you detested the old fact-cramming process and the more completely you have forgotten it, the less temptation for you to fall back on it in your science teaching. The scientific facts you know you will mostly forget, and if you are wise, the facts you learn each year you will forget each year and let the

children discover them afresh, like yourself. You have one infallible answer to all science questions, "I don't know; let's see if we can find out!"

And, since you are science teachers, you will use library facilities and specialists as little as possible, and turn to the scientific method to find the answers. You should adopt the principle of guiding your pupils to observe for themselves: by going as a class, by sending a delegation in or out of school hours, by bringing in the materials, or by performing experiments invented with the assistance of the class. Elementary science should be almost entirely personal observation and description. Textbooks, reference books, science readers, work books, even experiment books are very dangerous. Where they are not entirely informational, they take much of the spontaneity and initiative and most of the fun from the game. They are not only cut and dried, but temptingly convenient, almost fatally so. Perhaps they should all be carefully packed and sent parcel post prepaid to your dearest enemy to ruin her teaching and save your own. They are like girdles which weaken the organs they are supposed to aid. For students I recommend blank laboratory forms. For teachers there is a bibliography and suggested equipment list. Many materials can be gathered by the students, and it is better so. Much equipment can be improvised by the students also.

The complete scientific method as evolved up to today is too difficult for most grammar school pupils. However, it was developed gradually in three stages from very humble beginnings, and we can develop it gradually in three stages from very humble beginnings, too. Each stage will successfully solve problems of a certain type or degree of difficulty.

The first stage of the scientific method we owe to the genius of Aristotle, and Bacon, and others. It is simplicity itself and is the one for pupils to begin with. It may be called the method of Observation. It may be expressed in the phrase, "Look and See." It consists of two steps:

1. State the problem very simply and clearly. (Problem)
2. Look and See and so come to an answer and possibly an application. (Indications)

This stage is recommended for use in all grades. It is successful with only the simplest matter-of-fact problems that can be solved by direct observation, such as:

How many legs has a spider?
Which comes first, the thunder or the lightning?
How does the witchhazel scatter its seed?
Are the sunset colors prism colors?
Can we ever see the moon in the daytime?
Are all "stars" fixed in position?
Is heat lightning a distant thunderstorm?

This method is indeed absurdly simple, isn't it? And yet Galileo, when he announced discovering spots on the sun, was imprisoned and denounced as a liar by men who refused to look through his telescope!

The second stage of the scientific method we owe to the genius of Galileo. It is very simple, although it is advanced beyond the first stage. It may be called the method of Trial. It may be expressed in the phrase, "Guess and Test." It consists of four steps:

1. State the problem simply and clearly. (Problem)
2. Go and see all you can. (Indications)
3. Guess at the solution. (Hypothesis)
4. Test your solution by Trial and so come to a conclusion and possibly an application. (Test)

This method is recommended for use on suitable problems from grade 3 up. It is successful where stage number one fails and yet the problems are not of great difficulty, such as:

What is the matter with my swimming?
Why do I always have a headache on Sunday?
Would sawdust make a good garden mulch?
How can one put out an oil fire?
Does a rabbit foot bring good luck?
Should potatoes be planted in the dark of the moon?
Does handling toads cause warts?

This method seems a great deal like common sense today, in truth that is all the scientific method is, refined common sense. Yet I have heard people argue endlessly about these or similar questions. And do we not, all of us, know people that say, "I'm not superstitious. Not a bit! But I don't believe in taking any chances."?

The third or present stage of development of the scientific method we owe to the genius of Newton. It loses its apparent complexity with a little practice. It is often successful where stages one and two fail. It may be called the method of Verifying Deductions. It may be expressed in the phrase, "Predict and Experiment." It consists of six steps:

1. State the problem simply and clearly. (Problem)

2. Gather all the facts of any kind that might suggest a solution. (Indications)
3. Guess all the possible solutions that you can. (Alternatives)
4. Select the most likely or feasible alternative. (Hypothesis)
5. Predict some consequences which would logically follow if your hypothesis were correct. (Deductions)
6. Test these deductions by controlled experiments and so come to a conclusion and possibly an application. (Verification)

This method is recommended for all problems that can be solved by it in all grades above the 6th. It is often successful where the problem can neither be observed nor tried directly, such as:

Is air matter?
Why is it so much easier to roll a heavy barrel up a hill than to pull it up on a cart?
What is the law of the lever?
What is sound?
Why are most plants green?
Why are flowers never green when ripe?
Why do electric transformers hum?
How do the points on lightning rods protect buildings?

This is the complete scientific method as we have it today. All parts are not needed for the simpler problems. More parts, not yet devised, are needed for the most difficult problems.

In solving problems by the use of stage one, pupils get not only skill in that activity, a very valuable thing, but also familiarity with steps one and two of the complete scientific method. In solving problems by stage two, students acquire not only skill in a very useful technique, but also familiarity with steps one, two, four, and six of the complete scientific method. Any and all of these stages will be used in the higher grades, whatever method is appropriate to the problem in hand.

In the lowest grades, only problems that can be solved by stage one should be attempted. In the higher grades one may attack a problem with stage one, at first. If the evidence is direct, obvious, and overwhelming, stage one will suffice. If not, one may extend his investigation and so use stage two which will succeed where the evidence points to only one reasonable solution and that solution can be readily tested by trial. If, however, one does not obtain success in this way, he must reconsider the problem and use the six steps which together constitute the complete scientific method. If one sees at the start that the evidence is meager or contradictory, the possible solutions many, and the most likely one incapable of direct test,

he knows immediately that the complete scientific method is in order.

Even the complete scientific method will often fail. There are many problems in science that have not yet been solved by scientists less limited than we. There is no shame in failing when one tries. It is often under just such circumstances that one stumbles on a new and unexpected discovery.

It is well to have all investigations repeated by another party to make doubly sure of the accuracy and validity of the work. Professional scientists check and repeat an unbelievable number of times, and ask others to check their work besides. The principle of the controlled experiment, mentioned earlier, is very simple:

Between Similar Experiments, Similar Conditions Explain Similar Results; Different Conditions Explain Different Results.

ATWATER KENT MUSEUM

What may well be the oldest high school building in the country today has been rescued from razing by A. Atwater Kent, of Philadelphia, who has purchased the building which housed Franklin High School. The building was erected in 1825.

Opening April 6, 1826, to 304 pupils, the curriculum is an interesting milestone in public school education. The courses offered, with the enrollment indicating the popularity of each, were as follows: English, 300; French, 153; Latin, 105; Greek, 35; Spanish, 45; German, 20; Elocution, 300; Geography, 240; Drawing, 231; "and all of them Mathematics."

Sponsored by The Franklin Institute, the school carried on until 1832 and served as a model for the Central High School which was then established by the City of Philadelphia. The old stone building served as headquarters for the Institute for more than a century and remains a memorial to the Institute's long service to science and industry.

Purchased by the Atwater Kent Foundation, the building will be thoroughly repaired and then given to the city to be operated as the Atwater Kent Museum. Here will be gathered valuable relics and historic manuscripts which have long lain in storage in the basements of Independence Hall and Philadelphia's City Hall, or in possession of the Historical Society of Pennsylvania.

Independence Hall has more than a hundred portraits in oil of famous American patriots not on exhibition to the public; also, hundreds of manuscripts bearing on the formation of the federal government. The Historical Society has such relics as the silver watch of General Washington, and the desk and dining room chairs used by the First President during his Philadelphia administration; the swords of "Mad Anthony" Wayne and John Paul Jones, as well as the latter's telescope carried on the Serapis; portraits of Washington by Stuart, Willson, Peale and Rembrandt Peale; and those of Martha Washington, Chief Justice Marshall, General Lafayette, and many others.

THE TRAINING OF TEACHERS OF SCIENCE IN KENTUCKY

By Luther M. Ambrose
Berea College, Berea, Ky.

At the 1936 Annual Educational Conference held at the University of Kentucky one section allotted time for a discussion led by men representing the science faculties of the five public teacher training institutions of Kentucky. The subject of discussion was "What science courses should prospective teachers take in college." It was quite evident that there was no agreement in either theory or practice.

This lack of accord stimulated me to make this little study of the conditions, requirements for certification and possible standards towards which we might aim in teacher training curricula.

Last year there were 833 high schools in Kentucky.[1] Of these 675 were public high schools for white children. Of the 833 high schools 9 enrolled 1000 or more pupils, 25 enrolled from 500–1000, 313 enrolled 100–500, and 486 (more than half the total) enrolled less than 100 pupils. The high schools employed 5527 teachers, all of them college graduates except 308. Very few of these small schools have more than three teachers, some have only two, and 56 high schools (most of them junior high schools) have only one teacher.

In 1929 Mrs. Joe C. Grable[2] made a study of the status of the teaching of biological science in the secondary schools of Kentucky. Out of 640 high schools studied 213 taught biology. Of 85 biology teachers who answered her questionnaire only two had majored in biology, two in botany and two in zoology. Only three of the biology teachers taught biology only, 17 biology and one other subject, 62 biology and 2 other subjects, 38 biology and three other subjects, 37 biology and 4 other subjects, 12 biology and 5 other subjects, and 6 taught biology and 6 other subjects. Subjects most often mentioned were history, English, and foreign language.

In 1931 William Harris[3] made a similar study of physics

[1] "Organization and Classification of Kentucky High Schools 1935–1936." *Educational Bulletin*, Department of Education of Kentucky.

[2] Grable, Mrs. Joe, "Status of the Teaching of Biological Science in Secondary Schools of Kentucky." Unpublished thesis, University of Kentucky, 1929.

[3] Harris, William, "Status of the Teaching of High School Physics in Kentucky." Unpublished thesis, University of Kentucky, 1931.

teachers in Kentucky. He found that only 39 percent of the schools taught physics in 1928–29, that all but five of the 183 teachers taught other subjects or held administrative positions. One-half the physics teachers were also administrators. The most common combination with other courses was mathematics and general science; the next most common combination was with biology and English.

A similar study was made of the teaching of chemistry in the high schools of Kentucky, by Roy G. Smith.[4] In 1929–1930 there were only 98 high schools in Kentucky offering chemistry every year or every other year. This was 16.3 percent of all the high schools. This course was offered in the larger schools, the mean enrollment of the Southern Association schools teaching chemistry was 368.5 while for the A and B schools it was 131.9.

Of the chemistry teachers in Kentucky 46 percent had either majored or minored in chemistry. Seventeen and six-tenths percent taught chemistry only, 39 percent also taught general science, 37 percent also taught biology, 44.2 percent also taught physics, and 30.5 percent also taught mathematics. The most favored combination was chemistry and physics, the next most common combination was chemistry, biology, general science.

The National Society for the Study of Education[5] devoted Part 1 of its 31st year book to a study of science teaching. The criteria proposed for evaluating the program offered by a student to meet the requirements of a degree are:

1. "that the student may be prepared for the responsibilities of teaching in the position he is to fill and
2. "that he shall have attained respectable scholarship in his field"

The first of these demands really includes the second for a teacher must have a scholarly mastery of the subject matter before he is prepared to teach. It also requires a professional training that will give command of methods of teaching the body of content from his field that is taught in the elementary or secondary schools.

The education received in high school should be taken into account when one is considering the preparation for teaching. What high school science has been studied by our prospective teachers when they enter college? The most general offerings

[4] Smith, Roy G., "The Status of the Teaching of Chemistry in the High Schools of Kentucky." Unpublished thesis, University of Kentucky, 1932.

[5] National Society for the Study of Education *31st Year Book*, Part 1, p. 334, chapter 18 by S. R. Powers.

in science are general science in the ninth grade, biology in the tenth, physics in the eleventh and chemistry in the twelfth. Almost as many schools in Kentucky teach chemistry in the eleventh and physics in the twelfth as the other arrangement. Many alternate chemistry and physics.

A study of the high school credits of 1586 students entering state teachers colleges in Pennsylvania in 1928[6] reveal that all had credit for at least one of the four science courses. Eighty percent had taken general science, 72 percent had taken biology, 56 percent had taken chemistry, 43 percent had taken physics, 87 percent had taken two or more courses, and 55 percent had taken three or more courses. These figures for chemistry and physics are higher than they would be for freshmen entering Kentucky Teachers Colleges, judging from the low per cent of our high schools which offer these courses.

A survey of the science courses offered in 196 teachers training schools in the United States for the year 1924 and 1928 revealed a rare diversity of courses. Of 689 titles listed, 414 or 60 percent occurred only once and but 68 titles, or less than 10 percent, occurred 10 times or more![7]

The situation in Kentucky is more uniform than this study shows for the country at large, but there is certainly no close agreement on the science courses offered in our colleges.

The committee recognizing the fact that a science teacher must teach more than one science, often three or four, and quite often mathematics as well, and in keeping with the two criteria previously mentioned recommends that the following science courses be offered by all teacher training institutions.[8]

I. General or Orientation course required of all elementary-school and secondary-school teachers. The units of this work will be built around those generalizations and principles of science that relate most immediately to the needs and interests of liberally educated people. These will be chosen irrespective of the special field of science to which they may be related. (8 or 10 semester-hours of credit)

II. Beginnings of Specialization. Introductory courses in each of the special sciences—chemistry, physics and biology. Courses in botany and zoology may be offered instead of biology. (18–24 semester-hours of credit)

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[6] *Ibid.*, p. 326.
[7] *Ibid.*, p. 329.
[8] *Ibid.*, pp. 340–342.

III. Specialization

A. Chemistry	Second-year chemistry		8 hours
	Third-year chemistry		8 hours
B. Physics	Second-year physics		8 hours
	Third-year physics		4 hours
C. Biology	Second-year biology		8 hours

IV. Electives

A. Geology .... 4 hours
B. Physiography .... 4 hours
C. Astronomy .... 4 hours
D. Bacteriology .... 4 hours

The committee suggests the following minimums:

Elementary Teachers of Science

1. Orientation .... 8 hours
2. Introductory course in one special science .... 8 hours
3. Professional course in elementary science .... 4 hours
4. Electives in science .... 8 hours

Junior-High-School Teachers of Science

1. Orientation .... 8 hours
2. Introductory courses in three special sciences .... 24 hours
3. Specialization courses .... 8 hours
4. Professional course in junior-high-school science .... 4 hours
5. Electives in science and in mathematics at least .... 16 hours

Senior-High-School Teachers of Science

1. Orientation .... 8 hours
2. Introductory courses in three special sciences .... 24 hours
3. Specialization courses .... 16 hours
4. Professional course in major subject .... 4 hours
5. Electives .... 8 hours

Having surveyed the field and set our standards for preparation it remains but to check our state requirements against these standards and make further recommendations.

Since the committee does not recognize as properly trained for teaching those whom we certificate after two years of college, we will make our first comparisons with the Standard Elementary Certificate based on four years of college work and the A.B. degree. Since science is not required in Kentucky schools in any grade below the seventh we should not expect elementary teachers to be required to take many science subjects. Those who can read the hand writing on the wall see in the near future some series of science concepts in every grade. The new series of science readers now coming on the market and successful introduction of science into the early grades in experimental schools, show the trend.

National Society Standard		Kentucky Requirements[9]
Orientation	8 hours	Accepted in schools in which it is offered, as part of total requirement
Introductory course in one special science	8 hours	Total science 12 hours
Professional course in elementary science	4 hours	Not offered in Kentucky schools
Electives in science	8 hours	May elect science 27–30 hours electives permitted Health—2 hours
Total required	24 hours	Including Health 14

Kentucky does not issue a special certificate for junior high school teachers but considers junior high schools as high schools when so organized. Neither does Kentucky issue special certificates for teaching science or English or any other special subject except agriculture and music. She does specify the subject fields in which majors and minors may be taken. These presumably are the possible teaching fields for high schools.

National Society Standard		Kentucky Requirements for Provisional High School Certificate	
1. Orientation	8 hours	Possible in 21 schools	6
2. Introductory course in 3 special sciences	24 hours	Minimum for all courses	12
3. Specialization courses	16 hours	One major 24, 2 minors 18 or	60
		2 majors of 24 hours minimum if both majors are in science.	48
4. Professional course in major field	4 hours		
5. Electives	8 hours		
Total Science Credit	52 hours	14–60 hours	

It is worth while to bear in mind that although our state is to be complimented on the recent change making high school certificates valid for teaching in high schools only, it is still possible that a teacher who has prepared to teach languages may be put in charge of a class in physics. In fact, I once had

[9] "Manual of Organization of Instruction in the Elementary Grades." *Commonwealth of Kentucky Educational Bulletin*, Volume III, Number 6, August 1935.

a student in freshman chemistry taking his first course in chemistry, but he had taught high school chemistry for three years. In 1928–29 there were 14 physics teachers in Kentucky who had had no formal course in physics in either high school or college! Most progressive schools would not perpetrate such conditions on their children, but when the law does not prevent, we may expect to find the conditions it permits. What can be done about it?

The first suggestion is that special certificates be issued for the teachers in special subjects and good for teaching, only in the fields of preparation. This is the practice in many of our more progressive states. In Kentucky where more than half our high schools enroll less than 100 pupils it would be necessary to issue certificates for subject combinations such as science-mathematics, English-social studies, foreign language-English, etc.

The elementary school certificate should be immediately enriched by additional science requirements. The National Society for the Study of Education recommends 28 hours in science against 14 required for a Kentucky certificate. The former requires an 8-hour Orientation course. Such a course is offered in only two of Kentucky's Teachers Colleges, and these two courses are very different in subject matter. They carry 6 hours credit. None of our teachers colleges offer the Professional course in elementary science (4 hours) as recommended by the National Societies Committee.

Let Kentucky offer and require for certification:

1. A course in General Science at the first year level	6 hours
2. An introductory course in one special science. This should be a science not studied in high school. These courses might well differ from the pre-professional courses as usually given in the liberal arts colleges	9 hours
3. Professional course in elementary science	3 hours
4. Electives in science. (May be either an additional introductory course or a continuation in the course offered in number 2 above. In case the student has had only one science in high school besides general science, he should take the additional introductory course.)	6 hours
Total	24 hours

Our elementary schools are becoming science conscious. Teachers must prepare to meet the demands. Our teacher's colleges must offer the courses best calculated to prepare them

for this duty. They should all offer a general science course or orientation course at the freshman level and a professional course in elementary science at the sophomore level so long as we certificate after two years of college, and at the junior or senior level for the standard elementary certificate.

It is quite evident that if science is to be well taught in our high schools, our teachers must know the fundamentals in all the branches of science. Every teacher of any high school science should have had general courses in either high school or college in biology, chemistry, physics, geology, and astronomy. In addition, he should have continued in one of the first three sufficiently to major in it and have at least a minor in one other. This would make a total science credit of 60 hours. In case the student completed two majors in place of one major and two minors, as is permitted in some schools, the total science might be reduced to 54 hours. The second minor might well be in mathematics (which should include study through the calculus). In addition, he should have professional courses as follows:

1. Supervised student teaching..........................6 hours
2. Psychology..3 hours
3. Professional course in the teaching of high school science.....3 hours
4. Educational measurements............................3 hours
5. Electives in Education..............................3 hours

These requirements plus the usual English, health, social studies, and foreign language will total 117–123 hours of the usual 128 for graduation. This is no more rigid a requirement than is now held for those receiving the B.S. in agriculture.

By way of summary let me say:

1. Teachers of science in Kentucky high schools are not adequately prepared for the job.

2. Science should be, and is being, introduced into the first six grades.

3. The science requirements for elementary teachers should be extended.

4. A general science course at the freshman level should be required of elementary teachers.

5. A professional course in the teaching of science in the elementary schools should be required of all prospective elementary teachers.

6. Special certificates should be issued for the teaching of science, or science and mathematics, with special curricula outlined.

7. The high school science teacher should have had in high school or college introductory courses in each of the major fields of science, advanced courses enough to major in one or two fields, and enough for a minor in a third science field or in mathematics.

THE EFFECT OF HIGH SCHOOL CHEMISTRY ON SUCCESS IN BEGINNING COLLEGE CHEMISTRY

BY PAUL E. CLARK

Muskingum College, New Concord, Ohio

The question as to whether or not a course in high school chemistry enables a student to do better work in beginning college chemistry has often been discussed. Since the answer to this question is of value to chemistry teachers and pre-college advisers, it is a problem worthy of serious consideration and study. Although several writers have made reports on this subject, most of them have not had adequately controlled conditions to enable them to identify the effects associated with the taking, or the not taking, of high school chemistry.

Some time ago, the writer decided to try to determine, for Muskingum College at least, whether high school chemistry contributed to student success in first year courses. In this study,[1] he desired to control important factors in success other than that of background in high school chemistry. The factors which it was deemed necessary to control are: intelligence, some measure of the student's industry, and the chemistry course taken at Muskingum. The final semester grade in the first semester of college chemistry was taken as the criterion of success. The Ohio State University Psychological Examination percentile was used to indicate intelligence, and the student's six-weeks' grade-point ratio in all courses and his six-weeks' grade in chemistry were used to show work habits or industry. All students selected for the study were freshmen taking Chemistry 111, the more elementary of Muskingum's two first year courses.

A regression equation was developed for the control group (those having no high school chemistry) using the factors men-

[1] For data and more details, see *A College Looks At Its Program*, (Muskingum College Faculty, 1937), chapter vi, p. 57.

tioned above. The semester grades for the seventy-five members of this group were then predicted from this equation. The predictions were fairly good as is shown by the fact that the zero order correlation coefficient between predicted and achieved grades was found to be 0.71. This same regression equation was then applied to the experimental group (those having had high school chemistry), and thus their grades were also predicted. Fifty-four members of each of these two groups were then paired in terms of the predicted grades, and a comparison was made of the mean grades and the standard deviations they achieved. The mean grade achieved by the fifty-four paired students who had had high school chemistry was 0.30 ± 0.10 grade-points higher than that of the fifty-four who had no such training. The difference in these means is statistically significant, and since both groups were expected to average about the same, this shows that some factor was operating to raise the mean for the experimental group. This factor is believed to be the fact that they had high school training in chemistry. As a check on the adequacy of the pairing factor for a control, pairings were also made within each main group, and when this was done no significant differences developed between the sub-groups.

This study shows that when carefully controlled conditions were maintained, the freshmen taking Chemistry 111 at Muskingum during the first semester of the school years 1932–33, 1933–34, and 1934–35, made better semester marks on the average if they had had high school chemistry. These results have been useful in several ways. First, they have stimulated the writer to undertake further research along this line. Second, they have assisted the instructors in the department in sectioning students so as to arrange for somewhat homogeneous groups. Third, they have proved of value in advising precollege students who expect to take college chemistry.

DEVELOPER OF COTTON PICKING MACHINE TO RECEIVE MEDAL

Recognizing, among his other accomplishments, work in the development of a cotton picking machine, the American Society of Agricultural Engineers has chosen Edward A. Johnston, engineer and vice president of the International Harvester Company, as recipient of the Cyrus Hall McCormick Medal for 1938. He is to receive the medal at the annual meeting of the society next June.

GRAPHICAL ANALYSIS USED TO TEACH MOTION

By J. A. Douglas
Murphy High School, Mobile, Ala.

This report attempts to describe a presentation of some relations involved in motion. The process is that of graphical analysis based on mechanical differentiation. In this form the scheme has been used by the writer during three school sessions (1935–36 to the present) in the Murphy High School, Mobile, Ala.

The ideas inherent in velocity and acceleration as related to space and time concepts are dynamic rather than static. Furthermore, science and technics are now advancing through regions where even algebraic thinking serves rather poorly. Whereupon this development has some claim for attention.

Starting with the statement "velocity is the time rate at which space is covered," we may expect to have a diagram such as Figure 1 understood and accepted. It is not beyond reason to add that this particular graphical statement shows equal space covered in equal intervals of time. Therefore the speed of the object in question is the same at all instants (or all positions) while under observation.

Thus we may rightly insist we have described uniform velocity and promptly proceed to draw Figure 2. Upon doing so it is well to point out that the value (v_1, t_1) is determined by the ratio s_1/t_1, and likewise (v_2, t_2) by the ratio s_2/t_2, both being actually the slope of the space/time curve at these selected instants. Or, "velocity is the time rate of change of space." This leads to the further statement that "the slope of a curve is not only a ratio, but a ratio at any selected point," or more properly (and in better conformity with the calculus) it is the instantaneous rate of change of one variable with respect to the other at that point on the curve.

In this special case it thus appears that uniform velocity contemplates no variation of the rate of change of the space/time relation. Once a constant speed is established, all points on the space/time curve exhibit the same ratio. Hence the velocity/time curve remains the same distance from the axis of abscissas throughout the progress of such motion.

Passing to the acceleration/time relation, we can find no change of speed occurring. Thus there has been no acceleration, by the definition of that word, even though movement has been

continuous. At this point a restatement of the notion of acceleration is proper and even most desirable, viz., "time rate of change of velocity." Then, continuing to refer specifically to uniform velocity, it is pointed out that the slope of the velocity/time curve being everywhere the same and having everywhere the value zero, the acceleration/time curve coincides with the axis of abscissas, as shown in Figure 3.

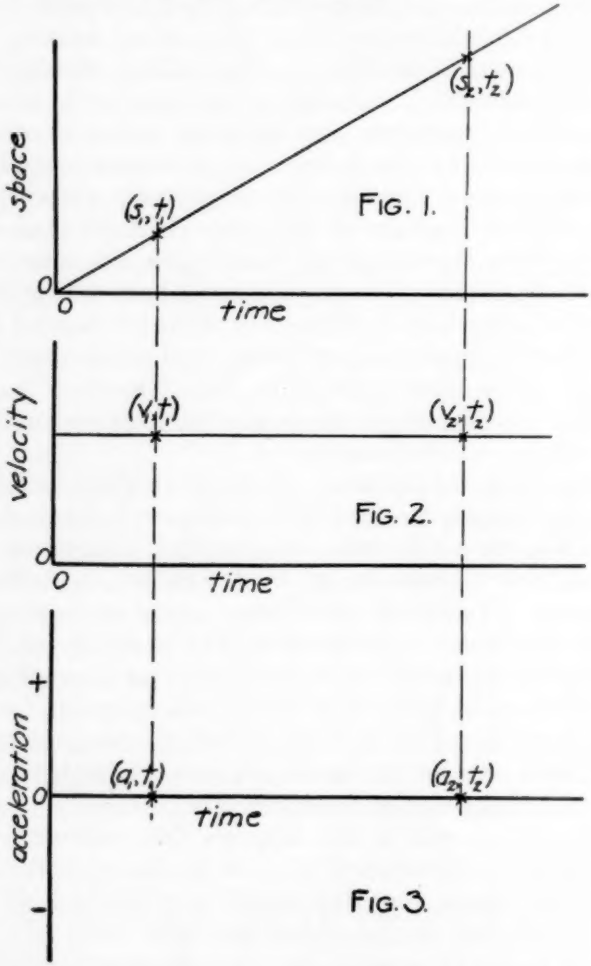


FIG. 1.

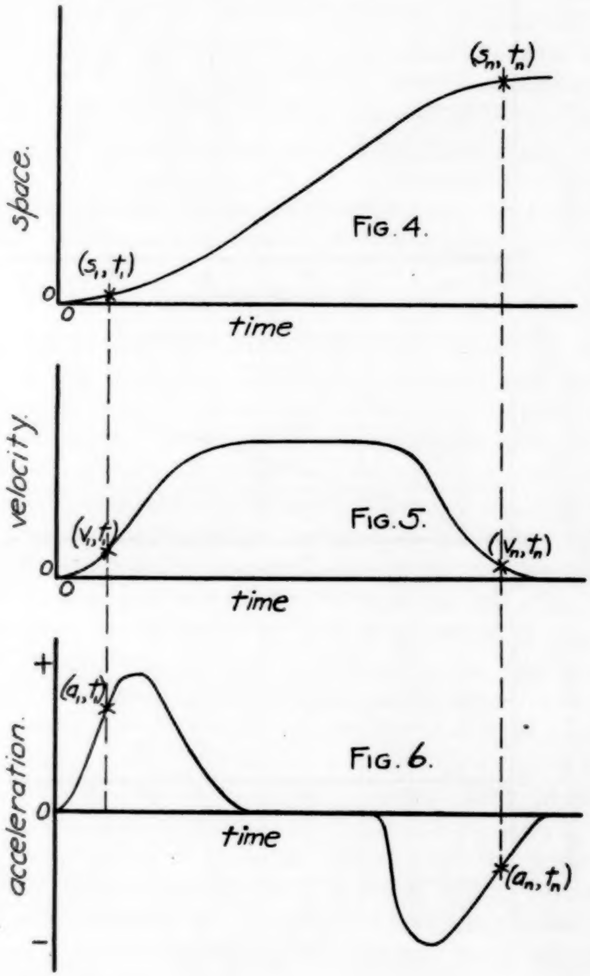
FIG. 2.

FIG. 3.

The next step has been to pass directly to variable velocity conditions. This may be done by assuming a trip from a position of rest to a stop at a distance from the starting point. For examples such things come to mind as an automobile in city

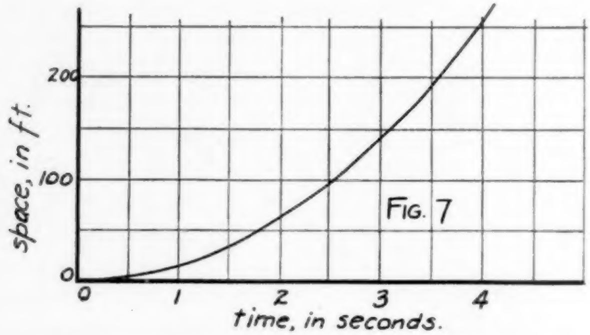
traffic, a train in local service, an elevator or mine hoist moving in its hatchway, or a runner making a 100-yard dash.

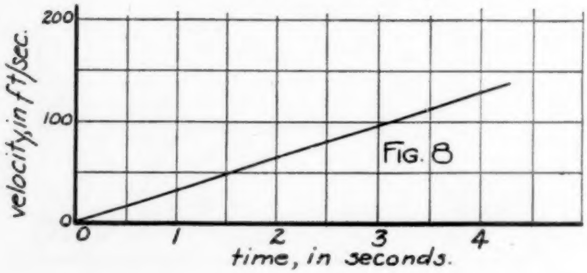
The space/time curve may be drawn as indicated in Figure 4. From this, without attempt at quantitative values, a corresponding velocity/time curve may be approximated as shown by Figure 5. Descriptive consideration of the variation of the

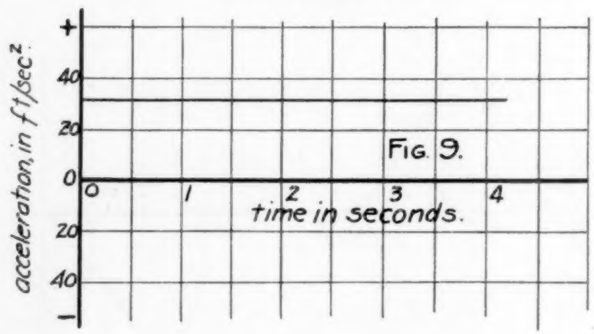


v/t ratio and the slopes of the velocity/time curve will then properly lead to the drawing of Figure 6, the associated curve of acceleration vs. time.

The final development has to do with the usual example of accelerated motion, namely freely falling bodies. After the above exposition of a generalized case, it is not hard to draw and to show validity for the graphical statements of this particular condition. Tabulated data of actual tests on falling bodies is







generally available, as e.g., the Army tests on falling bombs at Langley Field. Better yet is the use of a falling body machine in the laboratory—if such is available. It is desirable to plot a set of such data as a space/time curve. From it, using slopes,

a velocity/time curve may be derived. This being found to be a straight line, it may then be pointed out that a constantly increasing speed of this character exhibits a constant value for the associated acceleration. Furthermore, such constancy can be seen to follow from the identical value of slope exhibited at each instant of time by the velocity/time curve. More important, a velocity which increases directly as the first power of elapsed time can be seen to be derived (actually this is by graphical differentiation) from a space/time relation wherein space covered increases as the second power of elapsed time. That is, a continuously increasing value of slope is demanded in the space/time curve. Here then is the opportunity to show that time enters to the second power when acceleration is to be specified in terms of space and time, e.g., "feet per sec^2.," or as is the more usual expression "Feet per second per second."

Some Results

In using this procedure during the years mentioned, one day has been given to general discussion of the ideas basic to velocity and acceleration. This has been followed by the presentation of these sets of curves during the two succeeding days. A fourth day has been given to derivation of the expression for distance traveled with constant acceleration. A final day has been used for computation examples and assigned or volunteer pupil discussion of practical illustrations. The entire matter has thus been *presented* as new material, in the space of one school week.

Pupils have participated by drawing curves of space vs. distance, generally using railway timetables. In two instances sheets were presented to the class by pupils whereon they had drawn space/time curves for passenger trains in scheduled service. From these, using slopes, velocity/time curves for the same run were derived in correct relative time position in respect of the original graph.

From such instances it became clear that the trains were operated at highest speeds between stops which were closest together. The necessity for this could be seen, once it was understood that a specified average velocity was to be maintained over the entire run.

Conclusion

It is felt that this graphic method offers a somewhat improved understanding of the relations of space and time as involved in

the concepts of velocity and acceleration. The mathematics of the scheme goes no further than to introduce to beginners the most elementary principles associated with rates of change and relations between variables.

Even in this form it has shown a few pupils something of a unifying simplicity which exists in elementary physics. And it has produced some glimmer of the processes by which more serious physical ideas are developed. For instance, streamlining is not the only interesting thing being done to wheeled transportation devices these days. Of less publicity value but of more fundamental consequence is the determination of acceleration characteristics. These should permit comfort for passengers and crew, while permitting the equipment to attain or lose high speed in as short a time as is consistent with the safety of the traction mechanism. Determination of tractive effort or retarding forces on these sorts of vehicles or on rotating parts of other sorts of machines are applications of the method in industry. In the school room this graphical method is peculiarly effective in explaining the action of self-induction and of the transformer.

Wave motion, of course, is a fertile field for its use, but just as important is the fact that, once it has been introduced, it allows *variable* rather than static conditions to be discussed with some meaning.

EXTINCT MAMMOTH FOUND IN SIBERIA

Tusks scattered on the frozen shore of Siberia opposite Alaska may mean that Soviet scientists will some day add more complete specimens of the extinct hairy mammoth to the two bodies already found, Tass, Soviet news agency, reported here.

Detailed information on the body, the second one to be found, revealed that this hairy mammoth, as it existed thousands of years ago, was in the neighborhood of 18 feet long, had a trunk more than nine feet long and hair more than three inches long.

Like the first specimen found, the second body, which was uncovered last October, was partially damaged by wild animals. The head, one leg and a part of the trunk have been partly eaten away. Otherwise the body is intact, preserved through the ages in the frozen earth of the north, as effective an ice box as man has devised.

The tusks of the specimen found have not yet been located, but they may be under its body, which has not yet been removed from the pebbly ground. Next spring, when the sea in this area is clear of ice, soundings of the coastal zone will be taken to see if a ship can approach the shore to take on board the find.

CARTESIAN DIVERS DESIGNED BY PUPILS

BY HAYM KRUGLAK
Sheboygan High School, Sheboygan, Wis.

The construction of Cartesian Divers was one of the required home projects in our physics course. Four divers were outstanding in originality.

1. *The "diver in a diver"*

A small test tube *A* (Fig. 1) partly filled with water is the diver. Inside *A* there is a smaller diver *B*. When pressure is applied both divers go to the bottom. The edge of *A* strikes the bottom of the container, but *B* floats inside *A*. Additional pressure will cause *B* to sink within *A*.

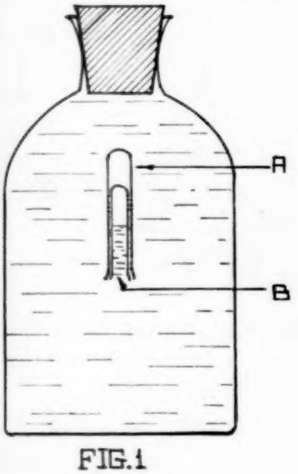


FIG. 1

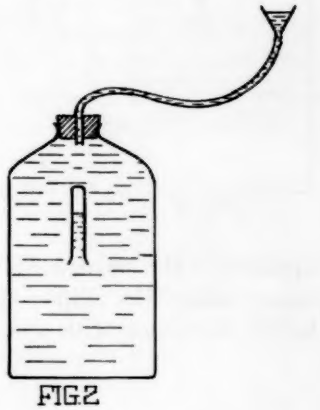


FIG. 2

2. *Hydrostatic Pressure Diver*

Hydrostatic pressure is used in the diver shown in Figure 2. By raising or lowering the funnel sufficient pressure change is produced to make the diver sink and rise at will.

3. *The Match Diver*

Instead of using a hollow container as a diver one of the students loaded a match with fine wire so as to enable the match to float upright (Fig. 3).

This diver behaves like the typical divers. Evidently the pressure applied is sufficient to change the density of the match and make it sink. When the pressure is relieved the elasticity of the wood restores the original density, and the match floats.

However, after several hours the match becomes waterlogged and sinks. Normal behavior is restored when enough wire is taken off to make the match float.

4. *Raising a Diver by Pressure*

The inventor of the Match Diver is also to be credited with the following ingenious application of solid geometry.

A diver is placed into a bottle with an elliptical cross section, e.g., whisky bottle (Fig. 4). Pressure is adjusted so that the diver is barely resting on the bottom. When the pressure is

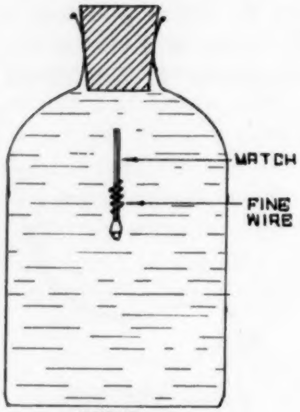


FIG. 3

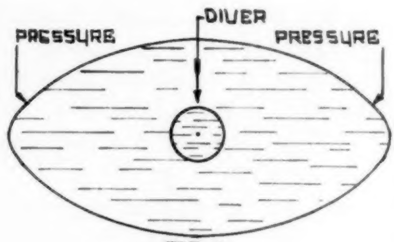


FIG. 4
TOP VIEW

applied to the narrow side of the bottle, e.g., normally to the minor axis of the ellipse, the diver rises, since the volume of the bottle increases with decreased elliptical cross section.

SUN RISE AT SAME HOUR FOR FOUR MONTHS

Superintendent Preston P. Patraw of Zion National Park has had the unique experience of seeing the sun rise at almost exactly the same time every day for four months.

From April 20 to September 1, Mr. Patraw reports, the sun's rays stream first into Zion Canyon within a few minutes of 7 o'clock in the morning. The unusual phenomenon is explained by the park superintendent as follows:

About April 20 the sun rises at 7:01 A.M. at the base of East Temple, one of the huge formations making up the canyon wall. On June 21, it rises at 7:05 A.M. at the top of the Temple, and by the first of September it again rises at the base of the formation at 7 o'clock. During the intervening time, the slope of East Temple is such that each day the sun's rays must be a little higher on the horizon before they can reach past the great rock hulk. Since the sun rises earlier each day, it would reach the slightly higher point on the Temple at approximately the same time.

THE OPERATOR "J" AND ERRORS IN THE LEARNING OF MATHEMATICAL CONCEPTS AND PROCESSES

BY J. S. GEORGES
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The theme of this paper is a brief study of the properties of mathematical relationships such as, the reflexive property the transitive property, etc. An abstract symbol is used to represent different concepts and processes in mathematics. In terms of this symbol properties of such concepts and processes are analyzed. For example, properties which they have in common, and the properties which are true for one class of concepts and processes are not true for another class.

The symbolic operator "J" is defined as follows:

$$J(A \circ B) = J(A) \circ J(B),$$

where A and B are numbers, real or complex; mathematical functions; or any mathematical entities: o is the symbol for any one of the four fundamental operations: and J is any mathematical process. The meaning of this abstract relationship is clear from the following examples.

1. Let $J \equiv$ coefficient c (multiplication), A, $B \equiv$ any arithmetic or algebraic quantities a, b.

Then, if $\circ \equiv \pm$, $c(a \circ b) = ca \circ cb$. **(1.1)**

If $\circ \equiv \times$, or $\div (b \neq 0)$, $c(a \circ b) \neq ca \circ cb$. **(1.2)**

2. Let $J \equiv$ reciprocal R; A, B any numbers.

Then, if $\circ \equiv \pm$, $R(a \circ b) \neq R(a) \circ R(b)$. **(2.1)**

If $\circ \equiv \times$, or $\div (b \neq 0)$, $R(a \circ b) = Ra \circ Rb$. **(2.2)**

3. Let $J \equiv$ exponent n (n any number); A, $B \equiv$ any algebraic or arithmetic quantities a, b.

Then, if $\circ \equiv \pm$, $(a \circ b)^n \neq a^n \circ b^n$. **(3.1)**

If $\circ \equiv \times$, or $\div (b \neq 0)$, $(a \circ b)^n = a^n \circ b^n$. **(3.2)**

4. Let $J \equiv$ limit; A, $B \equiv$ any functions.

If $\circ \equiv \pm$, $\lim\limits_{x \to c} [f_1(x) \circ f_2(x)] = \lim\limits_{x \to c} f_1(x) \circ \lim\limits_{x \to c} f_2(x)$. **(4.1)**

If $\circ \equiv \times$, or $\div (\lim f_2(x) \neq 0)$, $\lim\limits_{x \to c} [f_1(x) \circ f_2(x)]$

$$= \lim_{x\to c} f_1(x) \circ \lim_{x\to c} f_2(x). \tag{4.2}$$

5. Let $J \equiv$ Logarithm; and A, B any positive numbers.

If $\circ \equiv \pm$, Log $(A \circ B) \neq \log A \circ \log B$. (5.1)

If $\circ \equiv \times$, or $\div (B \neq 0)$, log $(A \circ B) \neq \log A \circ \log B$. (5.2)

6. Let $J \equiv$ differentiation; A, $B \equiv$ any differentiable functions.

If $\circ \equiv \pm$, $D_x[(f_1(x) \circ f_2(x)] = D_x f_1(x) \circ D_x f_2(x)$. (6.1)

If $\circ \equiv \times$, or $\div D_x[(f_1(x) \circ f_2(x)] \neq D_x f_1(x) \circ D_x f_2(x)$. (6.2)

7. Let $J \equiv$ integration; A, $B \equiv$ any integrable functions.

If $\circ \equiv \pm$, $\int [f_1(x)dx \circ f_2(x)dx] = \int f_1(x)dx \circ \int f_2(x)dx$. (7.1)

If $\circ \equiv \times$, or $\div$, $\int [f_1(x)dx \circ f_2(x)] \neq \int f_1(x)dx \circ \int f_2(x)dx$. (7.2)

8. Let $J \equiv$ any trigonometric function F; and A, B any angles θ and ϕ.

If $\circ \equiv \pm$, $F(\theta \circ \phi) \neq F(\theta) \circ F(\phi)$. (8.1)

If $\circ \equiv \times$, or $\div$, $F(\theta \circ \phi) \neq F(\theta)F(\phi)$. (8.2)

9. Let $J \equiv$ any inverse trigonemetric function F, and A, B any angles θ and ϕ.

If $\circ \equiv \pm$, $F(\theta \circ \phi) \neq F(\theta) \circ F(\phi)$. (9.1)

If $\circ \equiv \times$, or $\div$, $F(\theta \circ \phi) \neq F(\theta) \circ F(\phi)$. (9.2)

These few examples have special pedagogical interest. Many studies have been made to discover type errors made in arithmetic and algebra. The most exasperating types being the following:

(a) $c\left(\dfrac{a}{b}\right) = \dfrac{ca}{cb}$ · See (1.2). For example, $3 \times \frac{2}{5} = \frac{6}{15}$.

(b) $\dfrac{1}{a} \pm \dfrac{1}{b} = \dfrac{1}{a \pm b}$ · See (2.1). For example, $\frac{1}{2} + \frac{1}{3} = \frac{2}{5}$

(c) $\sqrt{a^2 \pm b^2} = a \pm b$. See (3.1). For example, $\sqrt{16+25} = 4+5$.

Likewise, the teachers of college mathematics discover "good" students making mistakes of the following types:

(d) $\log (a \pm b) = \log a \pm \log b$. See (5.1). For example, $\log 3 = \log 2$.

(e) $\sin(\theta \pm \phi) = \sin\theta \pm \sin\phi$. See (8.1). For example,

$$\sin 75° = \sin 45° + \sin 30°.$$

(f) $\sin^{-1}(\theta \pm \phi) = \sin^{-1}\theta \pm \sin^{-1}\phi$. See (9.1). For example,

$$\sin^{-1}\tfrac{1}{2} + \sin^{-1}\tfrac{1}{2} = \sin^{-1} 1.$$

(g) $\frac{d}{dx}(uv) = \frac{du}{dx} + \frac{du}{dx}\cdot$ See (6.2). For example, $\frac{d}{dx}\,\frac{x}{x+1} = 1.$

The college student who makes any one of the above mistakes, "knows better." If his attention is called to them, he feels chagrined. The high school student who makes mistakes of the types (a), (b), and (c) also knows better. Yet both in high school and in college the student makes these mistakes and others like them repeatedly. Surely then, there must be some factor involved in this phenomenon which has general implications, in non-mathematical fields as well. We wonder if our subconscious effort to make the symbolic operator J hold for all the four cases is not responsible for this state of affairs. Certainly, it seems that (1.2) is responsible for (a), (2.1) for (b), (3.1) for (c), (5.1) for (d), and so on.

It is a well known fact that we strive to generalize our experiential information. We do this generalization as a habit, without thought or rationalization, as if it were on the spur of the moment. Isolated perceptual experiences are often transformed into laws, with applications yielding sad results. May it not be of pedagogical interest to analyze errors in the learning and application of mathematical concepts and processes on this basis! The student's effort to make the process which we have represented by J to hold for all values of o seems to be the real cause of the trouble.

PATENTS

The issue of 774 patents by the U. S. Patent Office here brings to 37,695 the number of patents issued during the year 1937, a computation based on Patent Office issue numbers revealed. The figure represents an average of approximately 700 patents issued each week throughout the entire year.

A decrease of more than 2,000 patents in the number granted last year is recorded in the figures. The number of patents granted annually has been decreasing steadily from a peak of 53,473 during 1932, when the Patent Office was working to catch up on work then long overdue.

Figures for the last eight years follow:

1930—45,243; 1931—51,766; 1932—53,473; 1933—48,786; 1934—44,429; 1935—40,638; 1936—39,793; 1937—37,695.

SOME MODERN METHODS FOR TEACHING SCIENCE[1]

BY CHARLES H. STONE
144 Summerlin Place, Orlando, Fla.
(Student Aide, Master Tommy Shupe.)

(A.[2] Add dry Congo Red powder to a hydrometer jar of water. I. Display card "I make my bow!")

Fellow teachers,

We are all in the same boat. From Maine to Arizona and from Oregon to Florida, our problems are about the same. We all have to deal with the lazy and with the industrious student; with the stupid and with the intelligent boys and girls; with the smart Alecks and with the real student. We must be all things to all men. We must be as wise as Solomon, as patient as Job, as strong as Samson, as courageous as Peter, as kindly as the Good Samaritan, and as hopeful as Paul. We must know how to apply the old Latin motto, "Suaviter in modo"; and we must also be able to apply the second half of said adage, "Fortiter in re." Velvet, if you please, on most occasions, but iron when necessary. And school officials expect to engage the services of such paragons of all the teaching virtues at a salary out of all proportion to the service rendered!

(B. Stir the Congo Red with long glass rod dipped in acid. It turns blue.)

While there are many experienced instructors of Science throughout the country, there is, nevertheless, an army of young men and women only recently out of college who are trying the best they know to do efficiently the task to which they have been assigned. It may often happen that the task to which they are assigned is not one for which they are especially prepared; a Mathematics man may have to teach biology. These teachers have not yet had time to work out, by the trial and error method perhaps, a code of successful procedures. During an experience of some twenty years of teaching Sci-

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[1] A demonstrating lecture delivered before the Science Section of the Florida Education Association, March 19, 1937.

[2] (Note. Capital letters (A) indicate "mystery" experiments. Roman numerals (IV) indicate display cards. Arabic numbers (7) indicate experiments performed to illustrate the point under discussion. (X) indicates paragraphs included in the address but which, for lack of time, were omitted when speaking. Exponents indicate that directions for performing the experiment are appended to the article.)

ence, mostly chemistry, in a school of 3,000 boys, the speaker developed a number of methods which proved to be successful. Some of these will be presented here in the hope that they may prove of interest, and perhaps of profit, to the Science teachers now assembled.

(C. The long glass stirrer which has been standing in a tube of strong caustic soda solution is now used to stir the blue Congo Red which turns red. II. Display card: "Absent.")

Topic 1. Taking attendance. Do you waste five minutes each day when taking attendance by reading aloud your class lists? Don't do it! Seat your class any way you please, giving to the pupils with defective sight or hearing as good seats as possible well to the front of the room. Insist that each pupil sit always in the seat assigned. Make a seating plan of each class. When your class is seated, one glance will show what seats are empty; another glance at your seating plan will show what pupils are absent. In my own classroom, the chairs were numbered on the backs with figures large enough to be easily visible from the teacher's desk. If No. 7 and No. 24 were vacant, then Brown, L. G. and Morgan, F. H. were absent. Notation was made on the blank form which later was sent to the office. *(III. Display card; "Seating plan.")*

Topic 2. Prevention of cribbing. In large classes where students sit elbow to elbow, as you are now sitting, and as they sat in my own classroom, it was difficult to prevent students copying from each other during written tests. It is obvious that work which is not strictly honest is no indication of the pupil's real knowledge. After trying several plans, the following was found effective. The class was divided into five sections: A, B, C, D, E; arranged as shown on the blackboard.

	33	34		35	36	37	38		39	40		
	D	E		A	B	C	D		E	A		
	25	26		27	28	29	30	a	31	32		
a	B	C	a	D	E	A	B	i	C	D		a
i			i					s				i
s	17	18	s	19	20	21	21	l	23	24		s
l	E	A	l	B	C	D	E	e	A	B		l
e			e									e
	9	10		11	12	13	14		15	16		
	C	D		E	A	B	C		D	E		
	1	2		3	4	5	6		7	8		
	A	B		C	D	E	A		B	C		

You will note that no pupil in any section, say A section, has any other pupil in that section sitting anywhere near him. Now for the application.

difficulty in framing questions

Topic 3. Five minutes tests. Put upon the blackboard each morning five questions covering the work of the previous day, or five general review questions. Questions should call for brief answers only; avoid questions which can be answered by "Yes" or "No." Arrange a curtain or hang a chart so as to cover the questions. When the class is seated, each pupil receives a slip of paper on which he writes his name, home room number, date, and section letter, as: "Goodwin, J. K.; 207; March 19, 1937; C."

The curtain or chart is now removed. On the board you see a sample set of five questions on "Light." The teacher announces: "Section A will answer No. 3; Section B, No. 5; Section C, No. 1; Section D, No. 4, and Section E, No. 2." The section letter may be marked up opposite each question if desired to prevent confusion. Johnny soon discovers that it is no good looking at the paper of his neighbor at either the right, left, or in front, for not one of them is working on the same question which he himself must answer. It soon becomes apparent to Johnny that if he expects to pass on these daily tests he has got to do it on his own knowledge and not on wisdom gleaned from another student's paper. In a short time students pay no attention to the work of their seatmates.

At the end of five minutes, during which time the attendance is taken, the papers are collected and given to some student to sort, first by section letters and then alphabetically in each section. The slips are then handed to the teacher. As each slip contains only one short answer, the papers for a whole class may be corrected in a few minutes at the teacher's convenience. In this way every pupil recites once daily. Oral recitations will, of course, follow.

If any pupil's work continues to be unsatisfactory, the words, "You are not passing," are impressed on his papers with a rubber stamp. Such a pupil has no excuse to offer for a failure mark when the reports come out; there is none of the familiar song-and-dance stuff: "I thought I was getting by!"

Once in two weeks, or at the teacher's discretion, the papers are returned. This gives Jane and Johnny a chance to see about where they stand. Conference with the teacher may follow if they think the marks are not satisfactory.

If it be desired to use the same set of questions in successive classes, it is a simple matter to change the section letters so that an A student in class II does not have the same question that an A student in class I had. As there are several ways in which the order can be changed there is no need of repeating the same order in successive classes.

Topic 4. Drawing. In every science text there will appear here and there drawings of the various apparatus described in the text; in biology there will be drawings of plants or animals. Students should be required to reproduce these drawings as occasion offers. Only line drawings should be attempted; shading and perspective should not be attempted except by such students as are natural artists. No special preparation is required. All that is needed is a fair sense of proportion; a pen or pencil; a ruler; and a pair of compasses: if the latter are not available, two coins of different sizes may be used for drawing the curves of test tubes and flasks and the concentric curves of glass bends. This is an exercise of high value, for drawing is a universal language.

In my own classes, the first batch of drawings was generally pretty poor. The boys had done their work with little real interest. One or two of the best were pinned up in the show-case in the corridor; the rest were returned. When Jack and Bill wanted to know why they did not get back their drawings, the reply was made: "Your work was good enough to go in the corridor show-case." After class a group of students would gather in front of that case and you might hear such comments as these: "Huh! That's not so hot!" "Gee, I can do as good as that myself!" "You just watch me next time!"

When the second batch came in there was a marked improvement. There might be seven or eight pretty good ones. As before, a few of the best were pinned up in the show-case, care being taken to use work of students not represented in the first lot. Again a group would gather and comments would be made. It was not long before the majority of the class had made up their minds that they were going to have a drawing in that case or break a leg in the attempt. In one month's time a good teacher will have developed in his class a marked improvement in drawing, a "consummation devoutly to be wished." This can be done without any special urge or harping on the subject. The natural rivalry among students is the Open Sesame to success in this line. I want with all my power to urge the value

of drawing upon you. Here are some specimens of drawings done in my own school and here are some done in this school. Require every one of your pupils to draw the more important figured items as they occur in the course of your class work. I want to call especial attention to some fine work in the large biology room across the corridor from this room; also to some excellent drawings in the physics room. Don't fail to see them.

(*D. Alkali Blue Experiment.*)[1]

Topic 5. Bulletin board. Have a bulletin board put up in your room or just outside the door. On this may be pinned up clippings from newspapers, pictures, items of interest, etc. Appoint some pupil each week to act as editor of the board. Pupils will bring in much material. The name of each contributor should be attached to his contribution. Pupils like a little fame, you know.

Topic 6. Show case. In the corridor have a wall-case with glass front in which may be placed examples of good work done by pupils, such as: specimens of crystals, drawings of physics apparatus, glass lettering or etching, dyes and pigments made by students, biology drawings, etc. This will serve as a center of interest and also as an incentive to many pupils who want to see some of their own work on exhibition.

Topic 7. Exhibition charts.

a. Your attention is called to the series of exhibition charts displayed at the side of the room. These may be valuable adjuncts to your instructional methods, since they show in one place the main items of value concerning the topic under consideration in your class.

b. (*X*) Models. Boys who have some sort of shop where they can work with tools can make quite a number of working models. A derrick with cranks, and pulleys, 'n everything; a telegraph key and sounder that will work; a storage battery that will really operate; a home-made microscope; and various other models can be made by the youngsters who will enjoy the manufacture of something original.

c. (*X*) Exhibits. It is an interesting thing for Jane and Johnny to collect material, prepare samples, and mount the whole in a pleasing way. I cannot go deeply into this system of projects for it would take a whole address to deal completely with the theme. But here are some samples of what pupils can do along the various lines in which they are interested. Your inspection is invited.

(*E. Preparation of Orange II dye.*[2] *IV. Display card; "Dye Making."*)

Topic 8. Co-operation. Sometime you may have a student who displays a special interest along some unusual line. He may come to you with a proposition along that line. Now if you think the proposition is one which he could carry through, even if it is somewhat out of the usual order, co-operate with him. You never know when such an opportunity is the opening door to a deeper interest than could have been arrived at by the usual stereotyped methods. As an illustration, a short time ago a boy asked me how to make etchings on copper. Why he should be specially interested in that unusual feature I did not know and do not know today. He had never done any work along that line and neither had I. But we went to work on the problem and here is the result after only a little more than a week. There can be no question that this boy had found a way to chemistry along a new and untried road, but the experiment was worth while. You have a right to expect Bill and Mary to co-operate with you in the classroom and the laboratory. It is only fair that now and then you should show an interest in their small propositions and co-operate with them. Be interested in your pupils and in their work if you expect a similar interest from them. Co-operation is a fine thing between teacher and pupils and leads to harmonious conditions between them.

(*F. Preparation of Fluorescein.*[3] *V. Display card "Interest."*)

Topic 9. Interest. Half of the disciplinary troubles of teachers rise from the fact that Johnny is not much interested in the work of the classroom. This, and an abundance of natural animal spirits, leads to many of the small but annoying infractions of desired discipline. You must endeavor by every legitimate means to interest your pupils in the work, especially at the beginning of the year. When Jack and Robert are really interested in some of these projects which I pass around for your examination, you will have little trouble from them. Here, for example, are: Ink from iron nails; Orange II dye exhibit; Sprays exhibit; Pigment exhibit; Specimens of glass etching and silvering; Plaster of Paris exhibit which hangs on the wall behind me; and various others. The young people who made these things were too interested in what they were doing to have any time for monkey shines or "rough house" stuff. And if we are to admit that these things are departures from the regular routine of the manual in use, the wise teacher can infuse

into such work a good deal of chemistry in palatable doses, palatable because the student sees just how this fits in with what he is doing and how he needs to have this knowledge for the understanding and aid it will give him in his particular self-chosen project. Consider the value of this statement.

Topic 10. Development of interest. (*VI. Display card; "Demonstrate."*)

If you want to enlist the interest and stir the enthusiasm of your boys and girls, nothing you can do will exceed in effectiveness the well-conducted demonstration experiment. Progressive teachers are coming to appreciate more and more its value as a teaching agency and its power to illuminate and make clear some specific topic. Such demonstrational work needs to be done with care. But mark this: No demonstration, however well done, can attain its full effectiveness unless it be accompanied or followed by exhaustive questioning to make sure that the pupils have understood the purpose of the experiment, have seen the salient parts of the apparatus used and have understood the function of such parts; have followed comprehendingly the various steps in the physical or chemical changes which occurred, and have been able to reason correctly as to what they have seen and as to the conclusions to be reached. Under any other conditions, the demonstration is likely to degenerate into a more or less pyrotechnic display which at first amuses or interests the class but of which they soon tire, since they understand neither the purpose of the experiment, its progressive steps, nor the conclusions which they are supposed to reach. Remember; You are not there as a showman but you are there to illustrate and to illuminate the topic in hand to the better understanding of your class. You are there to impress upon them the importance of General Principles, which your demonstration may illustrate, rather than to require them to remember a multitude of unrelated facts. No house can long stand upon a feeble foundation, nor can any science be erected upon a collection of facts. Not until those facts are assembled and analyzed, until some general conclusions can be drawn from them do we have an organized science. Factual knowledge is good but it is secondary to a clear comprehension of those fundamentals upon which all special cases must rest. It is better for Johnny to know the place of iron in the Displacement Series and what may reasonably be expected to happen in a given case where iron is present, than it is for him to try to remember

that ferrous oxalate is of a tan color, and the precise difference between Turnbull's Blue and Prussian Blue. Dwell, therefore, on any fundamental principle which may be involved in your demonstration. Bring out the point by exhaustive questioning. The questions become, then, the essential concomitant of the experimental work. Hold fast to this!

I have emphasized the demonstration, so now let us try a few taken from a list of several hundred in my Summer School course; short ones only.

The text book states that manganese dioxide is a catalyst when used with potassium chlorate in the preparation of oxygen. The student has to accept the statement, but rarely has it proved to him. In this vertically suspended test-tube I have 7 grams of powdered potassium chlorate which my student aide, Lieut. Shupe, is heating from the side. Never heat a test tube directly on the end as that is the tube's weakest point. Presently the chlorate melts and by and by gives off oxygen, as the spark test shows. Now the heat is removed and the chlorate begins to cool. In a short time it has cooled enough so that it no longer gives off oxygen, as the spark test shows. Now I pour in 2 grams of manganese dioxide and at once test for oxygen. The test shows abundant evidence of the gas. Now the dumbest student in the class can hardly fail to see that the oxygen is being given off much more rapidly and at a lower temperature than when the chlorate alone is used. (*1*) Questions: What was the original substance in the tube? How was oxygen obtained from it? How did we know that oxygen was given off? When the heat was taken away, what would happen? Why did oxygen cease to be given off? What happened when the dioxide was poured in? Was the evolution of oxygen changed by this addition and how? What are your conclusions from this experiment? Another example of catalysis is shown here, omitting the questions for lack of time. Hydrogen peroxide gives off oxygen under ordinary conditions very slowly; the decomposition is slowed down by the action of acetanilide, a negative catalyst. I pour 20 cc. fresh peroxide into a small flask and test for oxygen; no response. Now I pour in 4 g. of manganese dioxide powder, shake gently, count ten, and test for oxygen. You see the result. (*2*)

Again, I have 10 cc. warm methyl alcohol in this flask. I suspend in the vapor a strip of platinum foil which has been warmed. You can see the platinum glowing red-hot, and this

will continue for a long time, until the air in the flask or the vapor is used up. The odor of formaldehyde can be distinctly noted after a little. (*3*)

(*X*). If you wish to show that nitrates contain oxygen, try this. Five grams of sodium nitrate are strongly heated in a vertically suspended test tube. The substance melts but gives off little oxygen. When the material is very hot, drop a splint with spark into the melt and withdraw the heat. Vigorous combustion will follow. (*4*)

Biology tells us that life is dependent upon the proper functioning of a combination of colloids. Let us consider this one. Will you come here Miss (Sanford)? Please stir with your finger the "milk" I am pouring into this small beaker. Keep stirring while I add a little dilute acetic acid. Stir, sister! Now what is on your finger? Hold it up so that all can see. This is pure white rubber and the "milk" was latex from a rubber tree in Brazil. I wash and dry the rubber and you can examine it. (*5*) (*VII. Display card: "Rubber booklet."*)

Topic 11. Pupil assistance. You will find it adds much to the interest if you call some student to the desk to co-operate with you on an experiment. So let me ask some of you to take the part of a student. Please respond promptly.

(*X*) The rubber just shown was a "gel." But there are "sols" also in our work. Mr. (Sarasota) please come up here and add a few drops of ferric chloride solution to the vigorously boiling water in this flask. The beautiful orange-brown liquid is a "sol" of ferric hydroxychloride. (*6*)

Now in all of these experiments, accompany or follow the experiment with abundant questions.

The study of physics takes up the topic of energy, and we have the energies of heat, light, electricity, and kinetic and potential energy.

Here I have some anhydrous copper sulphate powder, made by heating the blue crystal substance until all water was expelled and the blue color disappeared. Mr. (Daytona) let me put about a gram of this powder in the palm of your lily-white hand. Now I will add one drop of cold water and you will see the powder turn—but what are you prancing about like that for? "It gets hot!" Of course it does. When the water was driven out, heat was absorbed; when the water is returned the absorbed heat is liberated; a nice example of latent heat, Mr. Physics Teacher. (*7*)

When solutions are under consideration, the supersaturated condition may well deserve attention. Here we have a supersaturated solution of sodium acetate[4] made hot and allowed to cool. Under the right conditions the solute remains in solution instead of crystallizing out, as it generally does. Miss (Kissimmee) please come here. On the tip of this pencil there is a tiny speck of solid sodium acetate. Please reach down into the tube with the pencil, just touching the surface of the liquid, and then withdraw the pencil. Feel of the lower part of the tube. What is the temperature? "Cold!" We see that supersaturated solutions are in a very unstable condition for the liquid is "freezing" or turning to a solid. Now the action is complete, please feel again of the tube. "It is hot!" Well, why is it? (*8*) Latent heat again. Can you explain how we can have "hot ice"?

(*X*) What blood is to the animal, chlorophyll is to the plant, the iron in the blood being replaced by magnesium in the chlorophyll. Mr. (Lakeland) please grind in this mortar a handful of leaves (or grass) with sand and acetone. Finally drain off the liquid. What color is it? This is chlorophyll. Here is some of the same material in the dry state obtained from the Dept. of Agriculture. I dissolve some in alcohol and you notice the color. (*9*)

Topic 12. Pupil talks. It is a good idea, once in a while to have some student give a little talk before the class on some simple topic. I now yield place to Mr. James Cann who will discuss a certain chemical change. Mr. Cann. "In every chemical change, the original materials disappear as such and new substances with new properties are formed in their place. This small crucible is filled with powdered red dichromate of ammonium. I ignite the match head stuck deep in the center of the cone and you see a small volcano in action. The products are nitrogen, an invisible gas; water vapor, also invisible; and the "green tea" which you see is the chromium oxide formed by the decomposition of the ammonium dichromate. The equation is:

$$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + 4H_2O + Cr_2O_3 \qquad (10)$$

Miss LePage will represent Mr. Bennett's biology class.

Miss LePage. "Many plants in the course of their metabolism produce some form of sugar. Sugar beets, sugar cane, parsnips, onions, carrots, cabbage, and other vegetables do this. Some of these sugars are known as reducing sugars and the test for

them is Fehling's Solution. Here I have some sliced carrots which have been boiled in water. I pour 5 ml. of the liquid into a test tube, add 5 ml. of Fehling's No. 1 and enough of Fehling's No. 2 to make the liquid a clear dark blue. Now I heat the tube and in a moment you see the red color which is the test for reducing sugars.

A similar test made on Coca Cola produces the same result. (*11*) Miss MacKay will speak on Hydrolysis, representing Mr. Osborn's chemistry class.

Miss MacKay. "Hydrolysis is a chemical reaction between a normal salt and water tending to produce small amounts of the acid and the base from which the salt was formed. Soap is the sodium salt of stearic acid. Good soap contains no free hydroxyl. To prove this I add some alcoholic phenolphthalein to some soap powder and there is no red color. But when I fill the flask with water, the red color appears. The soap reacts with the water to form a small amount of highly ionized sodium hydroxide and a small amount of stearic acid which is hardly ionized at all. Hence there is an excess of hydroxyl ions which turn the phenolphthalein red. (*12*)

Mr. Bridges will now speak on "Lenses" representing Mr. Kirst's physics.

(*This talk was illustrated by blackboard diagram and by a set of lenses adjusted to show the images made by an electric lamp. The talk follows.*)

Mr. Bridges. "In our discussion of the telescope, we must first present a few simple facts concerning lenses.

"A lens is a transparent body bounded by surfaces at least one of which is curved. According to the form, there are two types of lenses; thick-edged and thin-edged. The thin-edge double-convex lens is the one with which we are all familiar as a magnifying glass or reading glass, and is the kind to be used in this demonstration.

"All parallel light rays upon passing through a convex lens converge upon a common point known as the focal point.

"In the telescope, light from a distant object passes through the large objective lens, converges, and forms a real image as can be seen on the screen. This image is inverted and is much smaller than the object, as is characteristic of all real images. Light from this image passes through the second lens and forms a second image which is a real image of the first image inside the focal point of the third lens or eye-piece. This image can

also be seen on a screen and is now in the same attitude as the object. Upon looking through the eye-piece, we see the enlarged virtual image of the second image. Light only appears to come from the position in which we see the image; in reality there is no light there." (*13*)

These four young speakers illustrate the possibilities that may lie in short pupil talks in your own classes. As your youngsters attain to more knowledge and acquire speaking confidence, their subjects may be enlarged to five or even ten minutes.

Returning now to our original plan, let us consider some experiments in another field. (*Display card; VIII "Explosives."*)

Will Mr. (Winter Park) please come here and heat the projecting end of the glass test tube contained in this shield. You might point the little cannon right at that black necktie over in the corner. Bang! Who has got the cork that closed the mouth of the tube which contained one gram of gunpowder? Gas pressure caused the expulsion of the cork. (*14*) Questions, of course!

Mr. (Bradenton) let me put on the palm of your hand this fluffed guncotton. Now do you realize that this is a very high explosive? Very well, but have you made your will? I touch a lighted match to the guncotton and; Pfftt! it is instantly gone! (*15*) Questions involving the subject of explosives and the use of nitric acid in connection therewith are in order.

I hold a grain of 75 mm. smokeless powder between the nails of thumb and forefinger and touch a lighted match to the grain. It burns. I blow out the flame and ignite the grain again. I blow it out the second time and relight it. (*16*) Notice how the seven holes lengthwise of the grain get larger as the grain burns. How will you explain "The Mystery of the Seven Holes" to your classes?

These and other experiments on explosives will interest your class and may be made the basis for an enlightening discussion and recitation on the subject.

Topic 13. Teaching equations. This is one of the bugbears of the chemistry teacher. Try this method. In this rack are several test-tubes; these may be filled half full of water in the presence of the class. Pupil No. 1 comes up and adds a few cc. of silver nitrate solution and then a few cc. of hydrochloric acid dilute. A white precipitate forms. He writes the equation on the blackboard. Pupil No. 2 comes up and adds potassium iodide solution and then lead nitrate solution and writes the equation. Colored chalk may be used to advantage to indicate the pre-

cipitate color. If Johnny asks how he is to know whether the precipitate is potassium nitrate or lead iodide, just put forward a bottle of solid potassium nitrate and let him make his own decision. Pupil No. 3 comes up and adds cobalt chloride and sodium phosphate and writes the equation, using purple chalk for the precipitate; and so on. Of course you will begin with the very easiest equations, gradually proceeding to more difficult ones and finally to the real hard ones like cobalt nitrate and potassium phosphate or ferric chloride and potassium ferrocyanide. (*17*) Since no pupil can foretell the color of precipitate he is to get, the exercise becomes a sort of game in which all are interested. I could go into this further, but time is passing.

Topic 14. Laws and Theories. (X. Actual demonstration omitted.)

Few of these admit of demonstration. Dalton's Second Law, however, is capable of excellent demonstration. Weigh out any amount of mercury up to ten grams. Weigh out 1.27 grams of iodine for every gram of mercury taken. Divide the iodine into two exactly equal parts by weight. Put the mercury into a dry clean mortar, add a little of the first portion of iodine, moisten with alcohol and grind. Continue the addition of the iodine until all of the first portion has been used. All of the mercury will have disappeared and in its place there will be a greenish powder which may be shown to the class. This is mercurous iodide. Now in the same way add the second portion of iodine, moistening with alcohol and grinding. A bright red powder results. This is mercuric iodide. Now the dumbest student can hardly fail to see that the amount of mercury is the same in both powders, but there is twice as much iodine in the second product as in the first. Dalton's Law may now be stated or repeated and the experiment offered as conclusive proof that when two elements, A and B, unite to form more than one compound, the weights of one of them which combine with a fixed weight of the other bear a simple ratio to each other. (*18*)

Topic 15. Oxidation and Reduction. On the basis of electron transfer, many interesting experiments may be done. In this upper bottle I have a solution of potassium permanganate and in the lower one a solution of sulphurous acid. I start the siphon by blowing through the short tube. The falling permanganate is instantly decolorized by the sulphurous acid. Consider the following equation and the form in which it is expressed.

Valence gain 2
Electron loss 2

$$2\,K\,Mn\,O_4+5\,H_2\,S\,O_3\rightarrow K_2\,S\,O_4+2\,Mn\,S\,O_4+3\,H_2\,S\,O_4+2\,H_2\,0$$

Valence loss 5
Electron gain 5

The manganese, which is the real oxidizing agent, goes from valence 7 to valence 2, a loss of 5 points and a gain of 5 electrons. The sulphur in the acid goes from valence 4 to valence 6, a gain of two valences and a loss of two electrons. Now the L.C.M. of 2 and 5 is 10; therefore to make 10, we must have 5 molecules of the acid and 2 of the permanganate. See how easily the coefficients of the substances are determined! *(19)*

Again, here we have 50 cc. of a solution of potassium iodate, very dilute; and here a very dilute solution of sulphurous acid. Both solutions contain starch paste. On the even second, as indicated by my assistant, the two solutions are poured into a tall graduate and well shaken. In 15 seconds, the whole thing turns blue.[5] Now it is evident that iodine must have been set free for the starch turned blue. So we have:

Valence gain 2
Electron loss 2

$$2\,K\,I\,O_3+5\,H_2\,S\,O_3\rightarrow I_2+K_2\,S\,O_4+2\,H_2\,S\,O_4+3\,H_2\,O$$

Valence loss 5
Electron gain 5

The iodine goes from valence 5 in the iodate to valence 0 as free iodine. The sulphur goes from valence 4 to valence 6. A loss of 5 in one case and a gain of 2 in the other. L.C.M. is, of course, 10. Hence to make 10 we must take 2 molecules of the iodate and 5 of the acid. Simple! *(20)*

(*G. Preparation of Primuline Red.*[6]) (*IX "Making Dyes."*)

Topic 15. The laboratory. Here is where the teacher must be constantly on the alert; to avert accidents, to correct wrong procedures, to make sure that the pupils understand what they are doing. No class should ever be sent to the laboratory without exact instructions as to what dangers to avoid, what procedures to follow, what the purpose of the experiment is, and other suggestions which will make the work of the period something more than blind following of directions. Here the teacher may talk over with pupils the work on which they are engaged, may correct errors in procedures or in written statements, and

may give a personal touch which is often sorely needed. Here the student's laboratory notes may be inspected, corrections made, and the notes taken up. In my own laboratory, when a sheet was taken up I knew that it was done, for it had been looked over with the student, and he had made the necessary corrections at that time; I had no further need to examine the notes.

One criticism which may be directed against some laboratory manuals is that they do not carry the experiment through to its logical conclusion. When Jack has made oxygen, why shouldn't he recover the manganese dioxide and potassium chloride remaining in the generator? When Jennie has prepared hydrogen and studied its properties, why should she not also recover the by-product zinc sulphate in its two forms, anhydrous and crystalline? Instead we let the pupil throw away the by-product and then buy zinc sulphate from the dealers. What is the matter with our common sense? The recovery of these residues is a good exercise and well worth the time it takes. Why leave off in the middle of the experiment?

It is in the laboratory, too, that Johnny may engage in some line of special interest, provided his other work is not in arrears. There are dozens of things in which he may undertake to carry on some special work. I cannot discuss these here, but I call your attention to the exhibits of pupils' work displayed in adjoining rooms.

(*H. Test for nitrites in drinking water.*[7])

In the laboratory, crystallization brings many interesting results. Dyes are fascinating; pigments are not difficult to make; sprays for trees will interest the boys; kitchen chemistry will absorb the girls' interests. Rubber; lead, iron, and copper compounds are colored and make a good display when well mounted. Such work stimulates interest and serves also as a bait for the poorer students. If Walter comes to you with a request to make something special, your come-back is: "Now, Walter, you know you are four experiments behind the class. But if you will get busy and catch up on that back work, why, then, we will see." As a rule, Walter will get down to business and soon surprise you with the last sheet of his back work, and then—Oh Boy! Any really good work by any pupil should go into the corridor show-case for the admiration of the general school public and as an incentive to others to go and do likewise. Every pupil would like to have something in that case.

And when Bill or Jack have done some good work and made an exhibit of it, they can take it home to show to "Pop" and "Mom," saying: "See here! I made this in Prof. Stewpid's chemistry class! Some chemist, Huh?"

Topic 16. Conclusion. There are a dozen other things I should like to talk to you about, but I have already tried your patience. Let me conclude by asking the celebrated artist, Miss Bruce, to paint my picture. Just rub over the white paper fastened to the blackboard with this cotton-batting swab dipped in ammonium hydroxide. Now look at that! Is not that a fine pose! And hasn't she caught the facial expression splendidly! I take pleasure in presenting this beautiful portrait to your Association, Mr. Chairman Beach![8]

Appendix

[1] Alkali Blue. Dissolve .1 g. Alkali Blue powder in dilute sodium carbonate solution in a flask. Tie a string to a small skein of wool yarn, wet the yarn thoroughly and, by means of the string lower the skein into the flask. Bring to a boil. Draw out the skein, squeeze out as much liquid as possible, and slowly lower the skein into a graduate containing very dilute hydrochloric acid. The blue color develops.

[2] Orange II dye. Dissolve 5 g. sulphanilic acid in sodium carbonate solution, as little as possibie. Cool and add 2 g. sodium nitrite dissolved in a little water. Now add 5 cc. conc. HCl, stir well, and let stand. Keep cold as possible, using ice if available.

Dissolve 4 g. beta Naphthol in water containing sodium hydroxide enough to cause complete solution.

Pour the first made solution into the second solution.

[3] Preparation of Fluorescein. Heat together in a dry test tube one gram each of phthalic anhydride and resorcin with a few drops of conc. sulphuric acid. Pour the brown product (liquid) into a hydrometer jar of water make alkaline with sodium hydroxide. The product is green by reflected light and from orange to pink by transmitted light.

[4] Supersaturated sodium acetate. Put into a clean dry tube enough finely powdered sodium acetate (C. P.) to fill the tube. Add about 1 cc. of water. Stand the tube in a flask containing 100 cc. water and boil the water. The contents of the tube should become entirely liquid. Remove the tube and support in a vertical position on a ring stand using a clamp. Stopper the tube with a washed cork stopper. When cold, the substance should remain liquid; if it does not, add a few drops of water and reheat. Do not heat over a free flame; it spoils the experiment.

[5] Potassium iodate and sulphurous acid. Dissolve one gram potassium iodate in 500 cc. water. Saturate 10 cc. water with sulphur dioxide and dilute to 500 cc. Using 45 cc. of each solution in separate graduates add 5 cc. starch paste solution and shake well. On the even second pour the two liquids into a larger graduate and shake or stir. In a definite number of seconds the change will occur.

[6] Primuline Red. Wet a strip of cotton cloth and boil it in a solution of Primuline. Transfer the yellow cloth to a beaker and cool with ice. Add some sodium nitrite solution and then enough hydrochloric acid, with stirring, to cause the entire cloth to assume a darker shade of yellow. Remove the cloth, squeeze out as much liquid as possible and lower into a

hydrometer jar containing alkaline beta Naphthol solution. The red will develop.

[7] Test for nitrites. Fill two hydrometer jars with water. To one of them add one gram of sodium nitrite powder, stirring till dissolved. To each of the jars now add 10 cc. of a solution of sulphanilic acid and then 10 cc. dilute hydrochloric acid. Stir and add a solution of alpha naphthylamine dissolved in dilute acetic acid. A pink color will appear in the jar containing the nitrite.

[8] Magic portrait. Dip a match stick in concentrated solution of mercurous nitrate and draw any picture you wish. Let dry. When dry the markings hardly show. Wipe over the dry surface of the paper with a wad of cotton batting wet with ammonium hydroxide. The picture appears.

NOTICE OF CHANGE IN OWNERSHIP OF EDUCATIONAL ABSTRACTS

Educational Abstracts, formerly published by Norman J. Powell and Associates of New York City, was formally accepted by the National Council of Phi Delta Kappa, professional and fraternal association of men in education, at its biennial meeting in Cincinnati, December 29, 1937. The November–December number of the magazine was published by the new owner.

The former policy of *Educational Abstracts* in summarizing and abstracting significant books and magazine articles in the field of education will be continued in a general way, but will be extended and expanded in detail. The first issue under the new management appeared in changed typographical style.

Paul M. Cook has been named to the editorship of the magazine, with W. A. Stumpf as associate editor. The editorial board comprises the executive council of Phi Delta Kappa, and includes Ira M. Kline, New York University; Arnold E. Joyal, University of Denver; Francis F. Powers, University of Washington; Allan R. Congdon, University of Nebraska; and John H. Aydelotte, Sam Houston State Teachers College, Huntsville, Texas.

A staff of 75 abstractors prepares the material for publication. *Educational Abstracts* is issued bi-monthly, five times a year. Editorial offices are located at 1180 East Sixty-third Street, Chicago, Illinois.

PALACHE FIRST ROEBLING MEDAL RECIPIENT

For meritorious achievement in mineralogy and allied sciences, Dr. Charles Palache, Harvard University's mineralogy head and retiring president of the Geological Society of America, was presented with the first Roebling Medal by the Mineralogical Society of America.

Noted for many years as a student of minerals, and famed as a teacher who could "put across" the complex science to his students, Dr. Palache is perhaps best known as the man who untangled the mysterious mineralogical puzzle in the zinc deposits of Franklin, New Jersey, where hundreds of rare minerals have been found by collectors.

The medal was established in honor of the late Colonel W. A. Roebling, bridge-builder and mineralogist, whose enormous collection of rare and beautiful minerals is now in the U. S. National Museum here.

NATURE RECREATION IN NEW YORK CITY

By William Gould Vinal
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1. Introduction

Abraham Lincoln once said: "I like to see a man proud of the place in which he lives. I like to see a man live so that his place will be proud of him." New Yorkers are proud of their nature offerings. Many great naturalists have come out of this great metropolis. Whether New York produces its quota of naturalists per square acre is not easily settled. Whether New York naturalists are born or made is a moot question. Follow one hundred workers home from a given office building and you will find few that do not have at least a dream-garden. Many will get out their nature collection. Their live stock may simmer down to a paper white narcissus, a cactus on the window ledge, a glass dish with guppies or it may be on as large a scale as a dog or a canary. Visit nature recreation centers and you will meet many of the hundred there. Some cities are sentencing children to a sea of bricks in a sooted fog. Not so New York City.

I fell under the New York spell for a month. A wood-born naturalist cannot like New York without some study and some sacrifice of prejudice. Standing on the curb hobnobbing with "reds" and "saints"; teaching leaders from East Side, Harlem, and all around the town; meeting-up with "inferiors" and "superiors" who are cheerful and optimistic amidst the grim, often sordid realities of life; trying to paint the sunnyside of dark alleys and cobble stones requires adjustment. Many unexpected nature-happenings arose to surprise me. Can you imagine more horses with milk wagons passing a Morningside apartment than the old homestead with its farm wagons in the heyday of farming? Eliminate the distractions of the city and hidden items of nature appear. New York's fresh air is made in Long Island Sound or in the Adirondacks and shuttled up or down the Hudson-Palisade ventilating shaft. For added precaution Manhattan has reserved one "lung" in the middle of the island familiarly called Central Park. The writer is fully conscious of the vastness of the subject and the impossibility of exhaustive treatment in a brief presentation. If the reader's

pet nature corner or nature hero is left out the author apologizes and blames it onto the lack of space.

2. The Colonial Period of Nature on Manhattan

An Englishman by the name of Hendrick Hudson, in employ of the Dutch East India Company, in his square-rigged Dutch craft, the "Half Moon," ventured into New York Harbor (1609) looking for "Spice Islands" in India. The Indians regarded the ship as a sea-monster. Hudson found the "Groot Riviere." Later the Dutch traded beads for fur. They were treated to a feast of fat dogs skinned with the help of sharp mussel shells. In 1626 "Manna-hatin" was bought from the "Men of India" or "Indians" for a few trinkets. A letter of Peter Schagen upon the arrival of the ship "The Arms of Amsterdam" at Amsterdam, November 5, 1626 listed the cargo as "7246 beaver skins, 48 mink skins, 36 wild cat skins, 33 minks, 34 rat skins. Many logs of oak and nutwood. Herewith be ye High Mighty Sirs commended to the Almighty's grace."

Bargaining for furs grown on Manhattan seems in the dim past, but listen to an old document of 1645 which includes the following animals on Manhattan. "Lions, but they are few; bears, of which there are many . . . There are besides, divers other wild animals in the interior, but these are unknown to Christians." There are said to be 42 ways of spelling Manhattan and 101 nicknames for the Flicker, so if any accounts of nature study in New York City irritate us perhaps we should again be indulgent as readers no doubt have had to be in the past.

Primitive settlements gathered around the forts and others about the orchards and gardens of manor lords. Corn and wheat displaced pine, chestnut and fur. Aromatic "Herbes" and simples were grown alongside the broader crops. Near the thatch-roofed cottages there were tulips and eglantine from the fatherland. Windmills, snowy geese, and the klingle, klangle of bells on the cows gave a Dutch atmosphere to the New Netherlands. The fence called the "Wall" (1644) built along Manhattan to keep out cattle, was to become "Wall Street." Peter Stuyvesant purchased the great "bouwerie" (farm) (1651) from which "The Bowery" is named. He established the Village of New Harlem (1658) to encourage agriculture. Stuyvesant surrendered New Netherlands without firing a shot. English government was proclaimed on June 12, 1665. Thus, there was

to arise a rich blend of Old Dutch and Old English nature lore in an American environment.

3. The Early Interpreters of Nature in Greater New York

a. *Species Hunters Along the Hudson*

Less than two hundred and fifty years ago Carolus Linnaeus (1707–1778) was born without a surname. His father took unto himself the name Lin from the linden tree. In 1732 the young Swede, with a fowling piece at his side, rode out of Upsala on a botany expedition to Lapland. Before this, if the herbalist wanted to know if a plant existed, he would look in the "Greek Flora" of Theophrastus (372–287 B.C.), a pupil of Aristotle, who classified plants into trees, shrubs, half-shrubs, and herbs. If the plant was not described then it couldn't be. Linnaeus did not classify this way but counted the stamens and pistils—the "sexual system." Linnaeus said that "System is a thread of Ariadne, without which botany is reduced to chaos."

Believe it or not, Dr. Cadwallader Colden (1688–1776) who lived in Newburgh was a contemporary of Linnaeus. Colden went afield in the good old Linnaean style—to collect and classify. The Swedish master published the results of Colden's studies in Orange County. Colden taught his daughter Jane Colden (1724–1766) to make leaf impressions with printer's ink. She knew Peter Kahn and John Bartram who visited her father. She was the first distinguished woman botanist in America.

John Torrey (1796–1873), Professor at Columbia, was also a pioneer botanist. As a youth he associated with Professor Amos Eaton. His "Catalogue of Plants Growing Spontaneously within Thirty Miles of the City of New York" (1819) was published by the Lyceum of Natural History. He was a progenitor (botanical, not genealogical) of Raymond Torrey who edits the *Torreya Magazine* and writes for the "Long Brown Path" of the *New York Post.* Background as well as training count in a community's program.

b. *Legendary Nature About the Hudson*

Washington Irving (1783–1859) discovered the Hudson for naturalists. As a boy he explored Sleepy Hollow and the Tappan Zee between Haverstraw and the Palisades with rod and gun.

He evidently caught more than game for he recorded rich history and great beauty along the Hudson. He pictured himself (1810): "Seated, leaning against a rock, with a wild-cherry tree over my head, reading Scott's *Lady of the Lake;* the busy ant hurrying over the page—crickets skipping into my bosom—wind rustling among the top branches of the trees. Broad masses of shade darken the Hudson and cast the opposite shore in black."

Irving once said: "To me the Hudson is full of storied associations." We can picture him talking with Revolutionary veterans. His humor and local color are entertaining. "A very orderly town; sober and quiet, save when Parson Mathias, who calls himself a Son of Thunder, is praying in secret so as to be heard across the river . . . the fiddle of Master Timothy Canty, who passed his livelong time in playing tuneful measures and catching bugs and butterflies." Irvington is a compliment to him but we prefer to think of him as from "Sleepy Hollow."

c. *Nature Songs of the Hudson*

Nothing can so pleasantly evoke the past as some remembered nature tidbit, some sweet flavored high top, the fragrance of new mown salt hay, or the color of lilacs.

John Howard Payne (1791–1852) was an actor but will be remembered as the writer of "Home, Sweet Home" (1823). When in London he was lonely and had little money. He was thinking of his humble home at East Hampton, Long Island, when he wrote:

> "Oh, give me my lowly thatch'd cottage again
> The birds singing gaily, that came at my call,
> Give me them and that peace of mind dearer than all."

Woodworth (1785–1842) used to dine with Bryant and James Fennimore Cooper (1789–1851) who wrote the *Last of the Mohicans* in New York City. Woodworth walked home (Duane Street) one hot day and said: "I'd like to have a drink from the old bucket in my father's well" (Scituate, Massachusetts). His wife suggested that it was a good idea for a poem. Within an hour he had written "The Old Oaken Bucket." This pastoral poem was so simple and true that like "Home, Sweet Home" it lives.

Alfred B. Street (1811–1881) sang of

> "Sweet forest odours that
> Have their birth
> From the clothed boughs and teeming earth"

His "A Winter Scene" and "A Day in March" were printed in the *Evening Post* in his fifteenth year.

Stephen Henry Thayer voices the woods and waters. At Tarrytown he is describing the opposite shores of Tappan Zee.

"And hedged against an amber light,
The lone hills cling, in vain endeavor,
To touch the curtained clouds of night,
That, weird-like, form and fade forever."

The writers of songs on the Hudson were simple folks who had the power to see. They were not dismayed by poverty. They had a love of nature and the truth. They had a will to work. Their works live after them. It is certain that they couldn't produce without experience. Out of such nature experiences must come creative expression.

d. *Manhattan Nature Writings in Prose*

In 1840 John James Audubon came to the forested bank of the Hudson (156th Street and Riverside Drive) to write and paint.

Horace Greeley (1811–1872) was born on a New Hampshire farm. One of his notable phrases was "Go West, young man." He founded the *New York Tribune* (1841) and purchased a 54-acre farm in Chappaqua (1853) where he spent his weekends. He carried on crop experiments and reclaimed swamps, and published *What I Know of Farming* (1871). Trees in his apple orchard may still be seen at Camp Edith Macey, the National Training Camp of the Girl Scouts.

Hamilton Wright Mabie (1845–1916) is another Hudson River nature man. He frequently visited Dr. Lyman Abbott and wrote *Nature and Culture* (1896).

Alice Cary (1820–1871) and Phoebe Cary (1824–1871) lived at 53 East 20th Street. They were born on a farm outside of Cincinnati and had a sincere interest in nature. For 15 years they had Sunday evening gatherings and the discussions of the notable company quickly gravitated to nature topics.

John Burroughs retired to what he called "Slabsides." Dr. G. Clyde Fisher of the American Museum had foresight to record John Burroughs' haunts and activities with colored lantern slides. John Burroughs had a reputation which could compete with old "Sherd" Minnerly, who "knew all the fish in the river by their Christian names."

Michael Pupin was a 15-year-old Serbian shepherd boy who

landed at Castle Garden with 5 cents in 1874. His autobiography, *From Immigrant to Inventor*, won the Pulitzer Prize in 1924. His life is a message of hope and inspiration. The Pupin Laboratory at Columbia University is a worthy kind of a memorial.

These representative naturalists are included by way of suggestion rather than being a complete list. In the "Hall of Fame for Great Americans" originated by Dr. Henry M. MacCracken (1899) while Chancellor of New York University appear the names of Bryant, Cooper, Irving, Agassiz, Audubon, and Gray. Four of these at some part of their lives lived in New York City. It is at least certain that the naturalists contributed quite as much to the many-sided metropolitan life as did the generals and statesmen.

4. Central Park Was the Beginning of a New Thinking

In 1830 there were still open places on Manhattan. The apartment house and the skyscraper had not been born. People had not begun to talk about a park. The swamp holes were miasmic and the outcrops of rock sheltered hermits and tramps. Near the hovels there were pigpens.

In the *New York Evening Post* for July 3, 1844, William Cullen Bryant editorially urged a park. It would be interesting to read his biography to see what in his life made it possible for him to write the first editorial for Central Park.

Andrew Jackson Downing (b. 1816) grew up in Newburgh. He was a sickly boy and perhaps this gave him time to enjoy nature. Like Colden and Irving he explored the hills and studied the plants and minerals. He was a graduate of "Nature's School" and as such was not in sympathy with grotesqued nature that was so common on rural estates. He wrote *A Treatise on the Theory and Practice of Landscape Gardening* (1841) and on the *Fruits and Fruit Trees of America* (1845). Downing was editor of the *Horticulturist* and in 1848 wrote *A Talk About Public Parks and Gardens*. While abroad he became acquainted with Calvert Vaux who returned to New York City with him. Andrew Jackson Downing was America's first great landscape artist. He conceived the practical artistic improvement of country homes and as such may be called the "Father of rural art."

Central Park was authorized July 21, 1853. It took three years to take over the 7500 parcels of land. Washington Irving

was the first president of the board (1856). A little later Andrew H. Green, "The Father of Greater New York," was elected president and treasurer of the Park Commission. In 1858 the plan of Olmsted and Vaux for the development of Central Park won first place. Central Park was completed in 1876.

Frederick Law Olmsted (1822–1930) was indorsed by Asa Gray and Washington Irving as the first Superintendent of the new Central Park. His father had a lively interest in nature study and as a boy the younger Olmsted was encouraged to discuss what he saw in rural scenery. He decided to become a farmer and in the summer of 1846 served as an apprentice on the farm of George Geddes near Oswego. In 1850 he traveled in rural Britain. All of this was important preparation for directing the picturesque compositions of Central Park. Following that beginning he developed parks which showed foresight and genius. His policies for park development are the foundation of American landscape architecture. The same kind of foresight is needed today to provide Central Park with equally extensive recreational and educational opportunities.

5. Teachers College, Columbia University, was an Early Force in Preparing Teachers to Teach Nature Study

Agassiz's Summer School on Penikese (1872)[1] included most of the leading science teachers of the country. His method was that of research for adults. H. H. Straight, a pupil of Agassiz, started nature study in New York at Oswego (1878). At Teachers College "the departments of Natural Science and Methods of Teaching were a part of the original scheme, but the professors in those departments were not appointed until the year following"[2] . . . The department of Natural Science was thus organized in 1888 with the appointment of John F. Woodhull as Professor of Natural Sciences (1888–1922). The Natural Science Section of the Illinois State Teachers Association was formed the same year. Professor Woodhull was a lecturer at Martha's Vineyard Summer School and Chautauqua (1887–1894) when Arthur Boyden (1889–1901) was giving courses in elementary science at the Vineyard and institutes for the

[1] Vinal, W. G., *Nature Guiding.* Most of the statistics of this paragraph are taken from the chapter on "The Nature Study Movement in America."

[2] Hervey, Walter L., "Historical Sketch of Teachers College from its foundation to 1897." *Teachers College Record*, Vol. I, January 1900, No. 1, pp. 12–35.

Plymouth County Teachers Association. Woodhull's book, *Simple Experiments for the School Room* (1889), preceded Jackman's *Nature Study* (1891). The Nature movement was not organized at Cornell until 1895 and then as extension work. Dr. Woodhull's *The Teaching of Science* was published in 1918. During this period the *New York School Journal* (1874–1904), Amos M. Kellogg, Editor, was presenting specific lessons prepared by Frank Owen Payne which were later published under the title *One Hundred Lessons Around the School*. Thus it will be seen that Teachers College was taking part in a widespread movement.

Nature lessons in the kindergarten were given in 1894[3] and Mount Vernon, anxious to introduce Nature Study in its course, sent to Teachers College for help.[4] When Edward Thorndike was at Western Reserve University (1898–1899)[5] he wrote that those who claim that the child who loves animals loves his fellows is not true. As proof he cited that the Hindoos who believe in transmigration have a cruel caste system. He went on to say that "Curiosity and not affection is the anlage for science temperament."

The second decade of nature education at Teachers College was the era of Francis E. Lloyd (T.C. 1897–1906) and Maurice A. Bigelow (T.C. 1899–1903). In 1898 a ten weeks course[6] was offered by Professor Lloyd which was entitled "Nature Study—A Special Treatment of Biology Applicable to the Elementary Grades." Lloyd and Bigelow also gave courses on the Theory and Practice of Teaching Biology in the Secondary School (1900). The American Teaching Series (1904) was based on 3–4 years of experience. Dr. Bigelow started the *Nature Study Review* and edited it for 10 years (1905–1915). It was a publication where teachers could get new ideas printed and served a great need. Nothing has taken its place since it was discontinued. Among the advisors and collaborators were L. H. Bailey, Clifton Hodge, John Woodhull, Harold Fairbanks, Charles E. Bessey, Edward F. Bigelow, A. C. Boyden, Richard Dodge, Frank Chapman, Bertha Chapman, Professor Ganong, Anna Comstock, Stanley Coulter, John M. Coulter, and Henry

[3] *Teachers College Bulletin*, January 1894, p. 17.

[4] *Teachers College Bulletin*, November 1894, p. 18.

[5] Thorndike, Edward, "Sentimentality in Science Teaching." *Educational Review*, January 1899, pp. 57–64.

[6] *Teachers College Announcement*, 1898–99, p. 24.

L. Clapp, all names of the first magnitude in the field of elementary science.

In 1900 Dr. Lloyd writes:[7] "The question is seldom asked nowadays whether or not the study of nature shall be made a part of the elementary curriculum." His aims were "scientific attitude of mind," "enriching of emotional life," "illumines rest of the work," "increases social worth." The authors recognize the necessity of preparation, that it is not confined to organic nature, that books have their place, that it is seasonal, and pertains to the immediate environment. The 5th grade work was in physics and references on physical science were made to Tyndall and J. F. Woodhull and in biological nature study to Jackman, Lange, Mrs. L. L. Wilson, the Cornell Leaflet, and to leaflets by C. F. Hodge.

Lester Burton Rogers in 1907 submitted a thesis[8] to Drs. Strayer and Bigelow on Physical Nature Study. He examined 101 courses representing 33 states. He tabulates the topics, time schedule, aims and meaning. The views of Dr. McMurray on the principles for the selection of subject matter and of Dr. Thorndike on observation are included. The thesis is an excellent critical survey of nature study at the beginning of the century. Rogers deplores the fact that physical nature study has been neglected and proceeds to show that this phase should be included. He believes that the difficulty was with the presentation and not with the subject itself.

Little appears in the university or city libraries about Woodhull, Bigelow, or Caldwell. It seems hardly possible that a university can be as impersonal as a factory. These men have been a real power in the field of nature teaching. They have approached the problem as scientists and teachers. They deserve more space than the writer is able to present.

The next decade (1912 to 1923) witnessed little in the way of Nature Education at Teachers College. Dr. Otis W. Caldwell came to the College in 1917. His experience in the Botany Department at Chicago and as special investigator of the school uses of gardens in Germany (1903) had been most valuable, but he had to give his time to the directing of the Lincoln Experimental School. Dr. S. R. Powers (T.C. 1923) and Dr.

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[7] *Teachers College Record*, Vol. I, No. 2, March 1900, 64 pp. "Course in Nature Study." Carss, Elizabeth, Supervisor of Nature Study in the Horace Mann School. Introduction by Francis E. Lloyd.

[8] Rogers, Lester Burton, "Nature-Study with Special Reference to Physical Nature-Study." Submitted in partial fulfillment of the requirements for the degree of M.A. in faculty of Philosophy. Columbia University.

Gerald S. Craig (T.C. 1927) approached the problem as educators. A new syllabus on elementary science soon appeared[9] which was a milestone in the progress of teaching. They both had a strategic position on the "Committee on Science Teaching," which issued the yearbook for 1932.[10] The book was revolutionary. It did not conceive nature education as a growth over a long period of years, and unfortunately gave no recognition to the nature study teachers of the past. The yearbook was a challenge to nature study putterers and was a Magna Charta or platform which ushered in a period of reconstruction.

6. The American Museum of Natural History is One of the Seven Wonders of New York City, Perhaps of the World

The first American Museum (1789) was founded by the Tammany Society. In 1810 John Scudder opened the American Museum at 21 Chatham Street which later became Barnum's Museum. "An abridged catalogue of the Principal Natural and Artificial Curiosities Now in the American Museum, J. Scudder, Proprietor, New York, July 1, 1819," appears in a frame at the City Museum on Fifth Avenue and East 104th Street. "A beautiful forest scene comprising birds, beasts and reptiles, among which are a beautiful spotted stagg killed at Plattsburgh April, 1817; the only one of the kind ever exhibited in America. Fawn from Long Island, cougar drowned in endeavoring to cross the Hudson River 30 miles north of this city (1818). Great black bear weighing 700 lbs. killed in Warwick Mountains 60 miles north of this city (1818)."

The present American Museum building program was conceived by *Andrew H. Green*, President of Parks (1858–1870), the ground plan and approaches by Frederick Law Olmsted (1875). A Museum, Zoo, Observatory, and Conservatory are mentioned in the original plans of Olmsted and Vaux.[11] Green[12] advocated the teaching of natural history in the public schools and went on to say that "The attention of all interested in education in this city may be fitly drawn to the Central Park—to what is already accomplished there, and for what is further preparing to be done, to render it a great storehouse of appli-

[9] Tentative Course of Study in Elementary Science, Grades I–VI. Horace Mann School. 1927.

[10] *Thirty-first Yearbook of National Society for the Study of Education*, S. Ralph Powers, Chairman, 1932.

[11] First Annual Report, Board of Commissioners of Dept. of Public Works, 1871.

[12] Foord, John, *The Life and Public Services of Andrew Haswell Green*. Doubleday, Page. 1913.

ances for the mental improvement of the youth of our city." The ideals of Green which united free public education and the Museum have become a tradition. His idea of Central Park as an educational center has yet to be realized.

Albert S. Bickmore was born on the coast of Maine. Graduating from Dartmouth (1860) he became a student and later an assistant to Agassiz. He broached the idea of a New York Museum but Asa Gray thought New York was too materialistic. Nevertheless Bickmore came from Agassiz's Museum of Comparative Zoology at Cambridge and told his plan to William E. Dodge, Jr. (1866). Bickmore's enthusiasm held the attention of the New Yorkers and he was made the first superintendent (1869–1884) when the Arsenal was its temporary home. The Museum was incorporated in 1869 and up to 1877 was a period of acquisition when Bickmore was traveling. Louis Agassiz prophetically said that "Whoever gets Hall's collection gets the Geological Museum of America." The American Museum acquired James B. Hall's collection from Albany.

Bickmore's greatest monument was educational work in the schools which he inaugurated in 1880 when H. C. Bumpus was director.[13] In this same year he started the "Bickmore Lectures" for teachers. These were notable for their high standard of quality. He headed the Department of Public Instruction until 1904, having devoted 36 years to the institution. The Honorable Joseph H. Choate (a founder and trustee of the American Museum)[14] although referring to Agassiz when he said "The acquisition of one truly great man by a University (Harvard) does more for the advancement of learning than whole decades of mediocrity" was thinking of Bickmore—a pupil of Agassiz.

To continue the Agassiz pedagogical tree and the American Museum: *Frederic Ward Putnam* (1839–1915) studied under Agassiz and was laboratory assistant (1857–1864). He came to the American Museum and was founder of *Anthropological Research* (1894). *Ralph Winfred Tower* (1870–1926) studied at Brown (1892) under Packard, a student of Agassiz. After developing a course in Physiological Chemistry at Brown (1894–1903) under Dr. Bumpus he came to the American Museum. Such are the ramifications of the leadership in early American natural science. They represent the dynamos from which the movement was projected.

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[13] Sherwood, George H., "The Museum in Education." *Natural History*, September 1930 (out of print).

[14] Choate, Joseph H., "A Commemoration Address." *American Museum Journal*, March, 1910.

Erwin S. Christman once pictured the American Museum as a "schoolhouse of the world"[15] toward which flamingoes, flying reptiles, dinosaurs and Indians are converging. Bigelow[16] said that "A science museum with educational aims must be planned to present the great principles (such as evolution) which make an intellectual appeal; it must teach the applications of science to practical life (that is, germ diseases, economic animals); and it must increase the aesthetic appreciation of nature and nature's processes." It is a fact that the aims of museums have constantly changed and the American Museum has always been in the lead. The existence of a Department of Public Health in a museum is unique. The American Museum now coöperates in teaching school hygiene and sanitation.

Frederic A. Lucas (1852–1929) was born in Plymouth, Massachusetts. His father was a clipper sea captain. Young Lucas sailed around the world twice in a square rigger. As an associate of Akeley, Townsend and Hornaday he received his early training at Ward's Natural Science Establishment. What Lucas knew about taxidermy came from an uncle who was taught by Professor J. W. P. Jenks of Brown. In 1904 Lucas was called from the National Museum to be Curator-in-Chief of the Brooklyn Museum. While there he made the Children's Museum a distinctive institution. He was then called to be Director of the American Museum (1911–1923).

The Department of Public Instruction is now under the direction of *George H. Sherwood.* The educational service is supported by the Carnegie Corporation and the Cleveland H. Dodge Foundation. There is also a special endowment for the instruction of the blind. The department is making a distinct contribution to education. Briefly there is the lantern slide service (1915) consisting of about 100,000 slides, a film library (1922) of 2000 reels, special exhibits for library reading rooms, auditorium lectures (1904), biology lectures under Paul B. Mann to keep high school students abreast of progress, intensive instruction in museum class rooms with aid of specimens supplemented by a trip to the particular hall involved, special activity crafts classes which carry on miniature habitat group making, finger painting and geography crafts, nature trails for museum halls, and four activity courses for teachers. Of special

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[15] *Natural History,* March-April, 1924, p. 254.

[16] Bigelow, "Educational Value of the American Museum of Natural History." *American Museum Journal,* November, 1911, p. 234.

interest to leaders is the coöperative plan with the School of Education of New York City College whereby five graduating students are assigned to the museum for four weeks of intensive training in museum methods and techniques as a part of practice teaching.

Progression centers around individuals. *William H. Carr*, Assistant Curator of Outdoor Education, has just brought forth a pamphlet on the history of *Nature Trailing*[17] at the Palisade Park. In 1907 there was the possibility of building a new Sing Sing in the vicinity of Bear Mountain Inn but the vision and quick action of public-spirited men including Theodore Roosevelt made it a park (1909). Perhaps the father of Museum Nature Work in the Palisade Parks was Benjamin T. B. Hyde (1920–1927) more familiarly known as "Uncle Bennie." A glacial boulder marks the site of his pioneer work shop to which flocked hundreds of boys. For three summers Dr. Frank E. Lutz carried on original experimentations with nature trails (1925–1927). In 1927 the trailside museum buildings and unique ideas of William Carr were begun at the Bear Mountain Bridge and extended south on the historic west bank of the Hudson. William Carr is a protegé of "Uncle Bennie." His notable work has been described in several museum publications. Felix Warburg made this Bear Mountain movement possible through eight years of financing. In 1927 the Laura Spelman Rockefeller Memorial financed it and since 1935 it has been state supported.

The Palisade Park is the largest camping park in the world. To this forty square miles of mountain woodland New York children flock from their rookeries. *Ruby I. Jolliffe*, as director of the one hundred organized camps, has always fostered nature study. Today there are 5 regional museums each with a competent staff. Each camp also has its nature counselor. Thus, there is a combined summer staff of nearly 150 naturalists in the park. The Palisade Park is a potent factor in things naturewise for New York City. It is the great metropolitan nature-playground.

The *Hayden Memorial Planetarium* was dedicated in 1935 and is under the leadership of *Dr. C. Clyde Fisher* who has always been an active friend and leader in nature education (American Museum since 1913). The planetarium is an outstanding example of human thinking. It is not only a plane-

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[17] Carr, William H. *Ten Years of Nature Training*, School Service Series, Number 12. 1936.

tarium but a school, theater, and mechanical world which can show a parade of stars as they were on the first Christmas 2000 years ago. The Zeiss Projector is 12 feet high and projects the stars visible to the human eye from any place on earth at any time. The black sky line of New York City encircles the "horizon line" of the white dome. Thus, the city that shuts out the heavens with its smoke and fumes presents the "Drama of the Skies" in a comfortable auditorium that seats 750 gazers at a time. Even a city can have its recompense but not all cities meet their obligations on such a magnificent scale.

The following year the State of New York Memorial to *Theodore Roosevelt* was dedicated (1936). The parapet wall bears the following: "A great leader of the youth of America, in energy and in fortitude, in the faith of our fathers, in defense of the rights of the people, in the love and conservation of nature and of the best in life and in man." In 1924 the State of New York appropriated $3\frac{1}{2}$ million dollars for the memorial. The cornerstone was laid in 1931. Three factors were considered in planning the memorial—the natural, educational, and idealism. The program of competition stated that "The nature lover should be stressed by monumental architecture, sculpture and mural paintings. The design should symbolize the scientific, educational, outdoor and exploration aspects of Theodore Roosevelt's life." The memorial blends these ideas. The huge granite columns support Lewis, Clark, Audubon, and Boone.

In the Memorial Hall his writings and sayings appear under four headings, one of which is nature. "There is a delight in the hardy life of the open. There are no words that can tell the hidden spirit of the wilderness, that can reveal its mystery, its melancholy, and its charm. The nation believes well if it treats the natural resources as assets which it must turn over to the next generation increased and not impaired in value. Conservation means development as much as it does protection."

Roosevelt's friend, John Burroughs, once said that "He probably knew tenfold more natural history than all the presidents who preceded him." The Roosevelt Bird Sanctuary at Oyster Bay commemorates his love of birds and work for their conservation. The Boy Scouts make an annual pilgrimage to his grave.

The doorway opposite the main entrance to the Roosevelt Memorial leads to the Akeley African Hall. This is most fitting as Akeley and Roosevelt were companions on several expedi-

tions. *Carl Akeley* (1864–1926)[18] was born on a small farm in western New York. At the age of nineteen he was an apprentice at Ward's. William Morton Wheeler entered Ward's in 1884 and was there when Akeley came. Akeley mounted Jumbo (given by P. T. Barnum) for the Tufts College Museum. This became an inspiration for later work. Wheeler became custodian of the Milwaukee Museum (1887–1890) and Akeley its taxidermist (1888). Later Akeley went to the Field Museum in Chicago (1895) and then to the American Museum (1909) where he conceived the idea of an African Hall. Akeley learned in the school of experience, and revolutionized taxidermy. He made it an art as Olmsted did landscaping. To Akeley, taxidermy was more than upholstering, or stuffing a skin, giving it two glass eyes, and a Latin name. He placed his animals in a natural environment and mounted them as though in action. He aimed for aesthetic and educational values. His grave is on Mount Mikeno in the sanctuary of the mountain gorilla, Parc National Albert. In 1924 Akeley married Mary L. Jobe. For four months she continued his work in the field in the Africa he loved. His work may be read in his book, *In Brightest Africa*, and it may be best visualized in the Akeley African Hall of the American Museum.

7. The Educational World is also Looking Toward the Botanic Gardens

It is easy to take our opportunities for granted. A New Yorker may attain the half century mark and not remember that there was a first time when the American Museum was opened on Sundays (1892) nor even be conscious that it required a conflict of mind and conscience to arrive at such a bold act. It was not until 1907 that the American Museum was free to the public every day in the year.

Aristotle endowed a botanic garden at Athens about 350 B.C. Those at Padua and Pisa, Italy were established about 1545. John Bartram (1699–1777), the first native American botanist, had more interest in living plants than in an herbarium. His Botanic Garden (1728) was three miles out of Philadelphia. We have already read of how he visited Dr. Cadwallader Colden at Newburgh. The "Elgin Botanic Garden" was laid out by Dr. David Hosack and planted where Rockefeller City is now located and is a source of a two million revenue per year to

[18] Akeley Memorial Number, *Natural History*, March-April, 1927.

Columbia University. For the most part these Botanic Gardens were devoted to research.

The New York Botanical Garden, Bronx Park (1894) is an educational as well as research institution. Popular lectures are given and in the Annual Report of the Director for 1904 it was recommended that "lectures designed with special reference to the needs of teachers and their pupils might be given with advantage." The Board of Education arranged for these lectures in 1905. The Brooklyn Botanic Garden aims at public education and has a program with the elementary schools. Founded "For the advancement and diffusion of a knowledge and love of plants" the department of public instruction is on the same basis as the department of scientific research.

The Brooklyn Botanic Garden (1910) is a Department of the Brooklyn Institute of Arts and Sciences. It is an outgrowth of the free public library (1823).[19] Like Central Park it was planned by Olmsted and Vaux. To give privacy it is surrounded by a "Border Mound"[20] of earth covered with woody stemmed plants. It consists of forty-three acres of plants for education and recreation set aside in the heart of the Borough of Brooklyn. The garden consists of greenhouses, classrooms, a native wild flower garden (1911), and a bog-swamp. The Japanese Garden (1915) is the first in a public park east of San Francisco and goes back to about 1000 A.D.[21] This garden gives preferences to evergreens and "dwarf trees" in miniature landscapes.

The Botanic Garden is on the southern margin of the terminal moraine which forms the backbone of Long Island. Many of the boulders were used in constructing the rock garden (1916). Twenty-eight Bronze Tablets appear on the larger boulders.[22] Here is a sample:

No. 6. Boulder of Micaceous Gneiss
Geological age, Precambrian
Transported by Continental Glacier
During the Ice Age
From Ramapo Mts., N. Y.

This outdoor museum of rocks furnishes the alphabet to the story of how the glacier quarried the ledges of the north and set them down as rounded "erratics" in southern New York.

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[19] *Popular Science Monthly*, April, 1912, pp. 339–345.

[20] *Brooklyn Botanic Garden Record*, May, 1929, pp. 153–188.

[21] *Brooklyn Botanic Garden Record*, November, 1931, pp. 279–294, 25¢.

[22] *Brooklyn Botanic Garden Record*, May, 1932. Guide No. 7, pp. 165–207.

For anyone who will become acquainted with the boulders of the Brooklyn Botanic Garden there awaits many a thrill in New York travels.

The "White Oak Circle" seems as ancient to Brooklyn boys and girls as the Druid Oaks to us. In 1916 a white oak was planted by Alfred T. White, "father of the Brooklyn Botanic Garden." The bronze tablet reads:

> "A fresh memorial as, each year,
> New life and buds and leaves appear;
> A living, monumental tree,
> True type of immortality."

The greatest memorial is being created in the minds of children. Over the entrance to the Children's Building, the little white house with an open door, is a quotation from the poet Wordsworth:

> "He is happiest who hath power
> To gather wisdom from a flower."

It is really a garden tool house where instruction is given as needed,—cultivation, carrot worms, thinning, and soil experiments according to the problems that arise. In what better way could one learn the value of orderliness or recognize the laws of nature? The Children's Garden accommodates 150 children who pay 25¢ for six months' instruction in an 8×10 outdoor garden. This important phase of the garden work is due to the creative genius of *Ellen Eddy Shaw*, Curator of elementary instruction since 1913. Miss Shaw makes the garden of everyday value to children. Children come every Saturday to the three greenhouses for work. The three cents a lesson impresses upon them the important lesson of the garden which teaches that "we cannot get something for nothing." The young gardeners learn to make cuttings, to plant bulbs, to repot plants, and to experiment with seeds. Miss Shaw's teacher-classes enrich the teaching of nature study and geography in the schools. Other cities who wish to inaugurate a garden centre send for Ellen Eddy Shaw. She is the same Ellen Eddy Shaw who edited the Children's Department for the *Garden Magazine* (1909–1915). Back of the scenes at the Brooklyn Botanic Garden is *Dr. Charles Stuart Gager*. A graduate of Syracuse (1895) and Cornell (Ph.D. 1902), he has been Director since 1910. If Dr. Gager is retiring, his work is outstanding and productive and it is by his work that we know him.

8. What are the Public Schools Doing in the Midst of such Notable Company?

New York City offers more teacher training courses in nature education than any other place in the world. Those interested in nature education may take courses under Van Evrie Kilpatrick at Hunter College; Brooklyn Botanic Garden, Dr. C. Stuart Gager and Ellen Eddy Shaw; the American Museum, Dr. George H. Sherwood; New York Botanical Garden, Dr. Forman T. McLean; New York Zoological Park, Dr. Claude Leister; Brooklyn Children's Museum, Anna B. Gallup; Teachers College of Columbia University, Dr. S. R. Powers and Dr. Gerald S. Craig; New York University, Dr. Charles J. Peipers; College of the City of New York, Morris Meister. With all these advantages and helps for the leaders in nature education one may well ask for an accounting from the schools.

Perhaps nature study first started in the New York city schools when Albert S. Bickmore brought fresh inspiration direct from Agassiz (1880). Frank Chapman[23] refers to the "Outline of Course in Elementary Science in the New York City Public Schools" (1897–98) and complains that "under zoology I look in vain for anything about the birds of New York City and vicinity." By 1904 the American Museum was delivering class room cases. In 1911, William H. Maxwell, Superintendent of Public Schools, championed nature study[24] when he said that "the study of nature is the foundation . . . of those ideals of life that make for improved conditions of living." In 1928 a new syllabus in Nature Study was adopted by the public schools.

For many years Van Evrie Kilpatrick was Supervisor of School Gardens in New York City. He was backed in his efforts to make "the garden the laboratory for nature-study" by the "School Garden Association of New York" (1908) which is an army some 10,000 strong.[25] The *Nature Garden Guide* has been published monthly to aid nature teaching through school gardens and nature rooms. Marvin M. Brooks has just succeeded Mr. Kilpatrick. Harold G. Campbell, Superintendent

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[23] Chapman, Frank, "Educational Value of Bird Study," *Educational Review*, March, 1899, pp. 242–249.

[24] Maxwell, Wm. H., *American Museum Journal*, November, 1911, p. 219.

[25] *A Guide to Nature-Study and School Garden Opportunities in New York City*, Handbook published by School Garden Association of New York in 1921. Van Evrie Kilpatrick, Editor-in-Chief.

of Schools, has recently said:[26] "The growing of plants in our classrooms and in our outdoor school gardens together with the assembling of nature material in our nature rooms is undoubtedly very valuable for city children. I look forward to the time when a greater number of teachers will take an interest in Nature Study." The present plans are for a "nature curator" in every elementary school. The Junior Garden Club Council Flower Show of the New York *Herald-Tribune* was held in August, 1936 in Horticultural Hall, Rockefeller Center. In 1935 the New York Society for the Experimental Study of Education established a nature section. Nature study is a growth. It is kinetic and not static. This is true in the New York schools as well as in the legion of organizations that are helping nature education along the way.

One of the outstanding efforts to popularize extracurricular science hobbies is the *Children's Science Fair* (1928) which is sponsored by the American Institute of the City of New York (1828).[27] The Fair is held annually at the American Museum of Natural History. Children of all ages and grades, individually or in groups, compete for prizes in the exhibit. In 1933 there were 500 projects representing 10,000 children. The *March of Science* is a bi-monthly publication sent to the sponsors with suggestions. It includes announcements of zone meetings, apparatus to exchange, a list of speakers, and arranges for a Science Congress.

All of the Nature Study in New York Schools cannot be called a "rose." Teachers can teach a subject and not recognize the specimen (The Chambered Nautilus). Teachers can still call the Natural History Museum for a model when they want a mounted bird (Robin). Teachers still ask for a stuffed specimen when they want a "habitat group" (Sea Beach). Growing tadpoles can teach more than some teachers. Children can recite a poem and then at Bear Mountain say "Oh, that looks like the flower on Miss Smith's hat." Children can chant the four stages of a silkworm moth and not know a caterpillar from a snake. City greenhouses are more concerned in growing plants to show than to use. The same is true of parks and triangles. A Manhattan bootblack can go to the Palisade Park and say "This is a hell of a place with no street to play in."

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[26] *Nature-Garden Guide*, September, 1936. Vol. XVI, No. 1.

[27] Meister, Morris, "Junior Science Clubs." *Science Education*, April, 1934, pp. 68–74.

Schools can draw up a course of study in nature and not provide the materials. All of this not only can but does take place in New York City Schools.

Alice Rich Northrop (1864–1922), a teacher in botany at Hunter College, saw how little was being done in nature study in the elementary schools. On a trip to the Bahama Islands (1890) Mrs. Northrop collected beach materials. In 1894 flower shows were started at Hunter College by a Natural Science Committee of her former students, and in 1900 the first public school flower show was held. Out of these experiences the School Nature League grew, and Public School 62 at 25 Norfolk Street on the congested East Side had the first nature room in New York City (1917).[28] The nature room is an oasis in a desert of brick. "In New York East Side schools of a thousand pupils it is sometimes true that more than 75% have never seen the country, and more than 50% have never seen even Central Park. There are schools where not even one member has ever seen grass growing."[29] The Board of Education allowed the League to change other vacant rooms into woodsy retreats and by 1920 seven schools had nature rooms. In the School for Crippled Children it was a "nature corner" and in the School for the Deaf the Assembly Hall platform was drafted.

The School Nature League is an outstanding example of nature philanthropy. It cannot be called an experiment as it has struggled persistently to bring the country to the city child since it was founded in 1917. The League home has been at the American Museum since 1927. Although in a poorly lighted basement room, the woods and fields have a friendly greeting for the stranger who enters its "gate." Some of the visiting children grow up to be high school volunteer-assistants. If they are really good they become paid workers. A graduate student at the University of Wisconsin profited by such an experience. The work may be illustrated by one concrete example:[30] "A sea beach—at first so unfamiliar. Sand is always fascinating, even if there is only a little—just enough to pour back and forth through the hand. An isolated shell,

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[28] Northrop, Mrs. John I. "Making Naturalists in Norfolk Street." *Natural History*, Vol. XXII No. 2, 1922, pp. 152–160.

[29] Northrop, Mrs. John I. "Nature and the City Child." *Natural History*, Vol. XX, No. 3, 1920, pp. 265–276.

[30] Northrop, Alice Rich, "Through Field and Woodland." *A Companion for Nature Students*. Putnam's. 1925.

or a starfish, or fragment of coral is an object of curiosity. But relate all these, spread them out on a table, and the interest is enhanced a hundred-fold. The imagination sees a miniature beach." With the help of friends the School Nature League is making miniature beaches available to hundreds of teachers. Multiply this effort by supplies made available to a thousand teachers and you will gain a notion of the purpose served by the School Nature League.

Alice Rich Northrop's book was published by friends after her unfortunate death through an automobile accident. Her biography, in the first part of the book, was written by Oliver Perry Medsger. Her summer home in the Berkshires near Great Barrington, Mass. has been established as a camp. Boys and girls are selected on alternate summers because of their interest in nature study. The camp is fulfilling her plan that children should learn informally rather than by class room instruction.

9. The First Children's Museum Was Established at Brooklyn (1899)

New York is proud of its nature study geniuses. Each has had an idea and belief enough in the idea to carry it through. That children should have personal experiences in the outdoors was the plan of Rousseau for Emile. That learning should be pleasurable was a novel idea once. The idea that Brooklyn should have a museum for children with voluntary attendance did not originate with a superintendent of schools nor with a teacher. Charles Goodyear discovered vulcanizing of rubber. His son William H. Goodyear, Curator of Fine Arts in the Brooklyn Museum, discovered an idea which may be just as practical, although heralded less.[31] He was inspired by the Museum Scholaire in Paris to provide a museum for the Brooklyn schools. It was originally planned for teachers but the children took it over by right of possession. In 1934 there were 600,000 children who took part.

When I visited the Brooklyn Children's Museum (December 1936) it had all the sorts of goings on you would expect in a beehive if you substituted children for bees. One has to be careful not to step on them so I got my back to the wall. Everyone had a job and knew where he was going. They could

[31] *Bulletin of the Brooklyn Institute of Arts and Sciences (1824)*, April 6, 1935.

be both seen and heard. Here was an epidemic of energy, curiosity, individual interests and capacities let loose in jigsaw puzzles, chasing down minerals, painting scenery for habitats, and just plain research in a 10,000 volume library. In one room there was a group of influential women who believe that the museum is worthy of support. They were planning a bazaar to get money to purchase more books and more wood for jigsaw puzzles. This was the Auxiliary of the Children's Museum (1915) organized for the "upbuilding of the Museum." From 1918–1922 it raised $10,000 and altogether has raised about $100,000. And probably these mothers were not unmindful of the new million dollar Children's Museum that the City Fathers are contemplating. Every corner of the hive was being used. If possible—and it is unbelievable until you see for yourself—the Children's Museum is surpassing Arthur Parker of the Rochester Museum in "making much out of little." It is a workshop of purposeful activities where children begin at three and having a good time keep it up until college days. Even after college some return to help at the treasure house of abundant living. And so what the Brooklyn children do in their spare time will largely determine the character of Brooklyn.

Such disorderly order requires leadership and in this instance it is *Anna Billings Gallup* who commenced her curatorship way back in 1902 with two rooms. Miss Gallup was born in the small country town of Ledyard, Connecticut. One time she was instructor in nature study in the Rhode Island College of Education. The Brooklyn Children's Museum now occupies two buildings—the St. Marks Avenue building being added in 1923. One might say that the Brooklyn Children's Museum is the life work of Anna Billings Gallup. Ask the man of the street where the Children's Museum is and the chances are that he does not know. Many highbrows do not know that invisible strings connect this idea with an army of 18 Children's Museums in Japan, Boston, Hartford, Indianapolis, Detroit, Oklahoma City and other places. In 1930 Anna Billings Gallup was awarded a gold medal by the National Institute of Social Sciences for distinguished service to humanity. This honor places her name cn the list with Madam Curie, Luther Burbank (1915), Michael Pupin (1917) and Liberty Hyde Bailey (1928). A feature article of this kind is not merely dates nor is it a compendium of names. It is a source of information on the

growth of the nature study idea in a given community. Put these stories together and you have the major story of the development of American nature study.

10. Conclusion

Nature recreation in New York City is a complex organization. Somewhere and somehow the opportunities for nature recreation touch the daily lives of most individuals. It is an ever widening program which is within the range of experience, interest, and ability of every citizen. The important thing is that every child be brought within the influence of these wholesome contacts that he may have worth-while interests when he becomes an adult. An exhibit of the rayon industries at the Brooklyn Museum of Arts and Sciences shows that within 25 years rayon has become a major textile fiber. Four hundred and sixty items are now made from cellulose which includes such things as imitation furs, silk neckties, films, cellulose straw, cellulose horse hair, and cloth with reptile skin effect. A cellulose sponge can absorb twenty times its own weight in water. In the exhibits there are charts to show tensile strength, the acetate process, the viscose process, employment, and wages. The leaders in the Rayon Industry know what to expect in textile fibre consumption in 5 and 20 years from now. Their engineers have invented a fade-o-meter. Do we not need equally efficient engineers in nature recreation who can tell us by chart and compass what the human products of nature recreation are—the strength of the sinews which result—and where we are headed for in 5 and 20 years? If the home is to be the center for an increasing percentage of leisure time nature activities, if nature recreation is available at a low cost we should know this that we can usher in an era of nature recreation with intelligence. Without happy humans with an abundance of health rayon will be an anomaly.

YOUTH PRIZE IN PURE CHEMISTRY CONTINUED

Youth in chemistry will continue to be recognized by the American Chemical Society through an award next year of $1,000 to some researcher under the age of 35 working in pure chemistry. Prof. James E. Kendall, head of Edinburgh University's chemistry department and formerly at Columbia and New York University, has provided this prize for 1938, continuing the award established in 1931 by A. C. Langmuir.

BIBLIOGRAPHY OF POPULAR MATHEMATICS

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Introduction to Bibliography

The average High School Mathematics Club cannot run itself. What is true as to the need for supervision of all school activities is particularly true of the Mathematics Club. Club meetings require the preparation of interesting programs along mathematical lines. Thus there persistently rises, like a spectre before us, the insatiable question "What shall we do next?" For several years I have served as faculty adviser for our students' Mathematics Club at Eastern High School, Washington, D. C., and previously have worked with similar clubs in colleges where I have taught. These experiences have led me to the belief that there exists a need for a broad, usable bibliography of popularly written material on mathematical subjects—a storehouse that can be drawn upon in accordance with the needs and interests of those in the Club.

With this in mind I started about two years ago to construct such a bibliography. I found that the sources which were most readily available to school clubs and like organizations divided themselves into two main classes: Firstly, a limited number of books published in this country and in England which could be available in school or public libraries; these include some standard and more recently published histories, and books dealing with mathematical recreations, and the like. Secondly, miscellaneous popular magazine articles written for the layman, or those interested in mathematics as an avocation, generally presented in entertaining and non-technical language. Included also in this second list is a number of articles from leading professional journals, such as School Science and Mathematics, *The Mathematics Teacher*, etc. Thus, the bibliography is in two sections: (A) books; (B) periodicals.

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12. "Geometry Humanized," *Math. Teacher*, Feb., 1928.
13. "A Little Journey to the Land of Math," *Math. Teacher*, Oct., 1924.
14. "Mathesis," *Math. Teacher*, Dec., 1927.
15. "A Number Play in Three Acts," *Math. Teacher*, Mar., 1924.

STAINLESS STEEL THERMOMETER FOR LABORATORY USE

An entirely new type of laboratory thermometer, provided with a dial-and-pointer scale encased in stainless steel, mounted on top of an 8-inch stainless steel stem, is being introduced by the Weston Electrical Instrument Corporation, Newark, N. J.

The unit is said to be the first dial-type thermometer with an all-metal temperature element sufficiently accurate for scientific use. The pointer is actuated by means of an internally balanced double coil of thermostatic bimetal sealed in the lower 1-½ inches of the seamless stem. When the stem is immersed to a depth of 1-½ inches in a liquid (3 inches in gas or vapor), the dial reads temperature values accurately without the necessity for stem correction.

Accuracy of the unit is guaranteed to ½ of 1% over the entire scale. In practice, the location of the dial at the top of the stem, removed from the liquids or vapors under measurement, encourages a further increase in the accuracy with which readings are made. Dial markings are spaced for maximum readability on the metal scale plate, and are not subjected to obliteration from the solutions under test, as is the case with stem gradations. The low temperature values are not obscured in dark-colored or viscous solutions.

The stem of the unit which encloses the temperature element is ¼-inch diameter high-strength seamless tubing of "18-8" chromium-nickel alloy steel. It is extremely rugged and completely corrosion-proof to all but a very few laboratory reagents. Construction of the temperature-sensitive coil is also inherently rugged and shock-proof. Reasonable overrange temperatures will not affect the accuracy of the unit.

Initial models of the unit are being offered in the following scale ranges; 0–220°F., 50–300°F., 50–500°F., 0–100°C., 0–150°C. Applications include temperature measurement in educational and industrial research laboratories, in control laboratories, hospitals and general scientific use.

EASTERN ASSOCIATION OF PHYSICS TEACHERS

One Hundred Thirty-Seventh Meeting

MILTON ACADEMY

Milton, Mass.

Saturday, December 11, 1937

PROGRAM

9:50 Meeting of the Executive Committee.

10:00 Report of the Membership Committee.
Mr. Carroll H. Lowe, Chairman.
Report of the New Apparatus Committee.
Mr. Hollis D. Hatch, Chairman.
Report of the New Books and Magazine Literature Committee.
Mr. Charles B. Harrington, Chairman.
Book Review: Mr. Floyd E. Somerville.
Demonstration: "Some Laboratory Uses of Compressed Air and the Amplifier." Mr. Homer W. LeSourd.
Teaching Demonstration with a Class: Mr. Burton L. Cushing.

12:00 Luncheon. Social hour, and visit to Academy buildings.

2:00 Greetings: Mr. W. L. W. Field, Headmaster Milton Academy.
Address: Dr. Karl T. Compton, President of the Massachusetts Institute of Technology.
Address and Demonstration: "Some Research Methods at Very Low Temperatures" Dr. Harold T. Gerry.

OFFICERS

President, Ralph H. Houser, Roxbury Latin School, West Roxbury, Mass.
Vice-President, John P. Brennan, High School, Somerville, Mass.
Secretary, Carl W. Staples, High School, Chelsea, Mass.
Treasurer, Preston W. Smith, 208 Harvard St., Dorchester, Mass.

COMMITTEES

New Books and Magazine Literature—Charles B. Harrington, High School, Newtonville, Mass. Prof. Charles W. Banks, Wentworth Institute, Boston. Thomas C. Bailey, High School, Hartford, Conn.

Membership—Carroll H. Lowe, High School, Brookline, Mass. Anna E. Holman, Winsor School, Boston, Mass. Arthur B. Stanley, 14 Hundreds Circle, Wellesley, Mass.

New Apparatus—Hollis D. Hatch, English High School, Boston, Mass. Dr. Andrew Longacre, Phillips Exeter Academy, Exeter, N. H. Temple C. Patton, Worcester, Academy, Worcester, Mass.

BUSINESS MEETING

The following were elected active members;
Miss Gabrielle Asset, Dana Hall School, Wellesley, Mass.
Richard P. Boyer, Newton High School, Newtonville, Mass.
Albert R. Clish, Belmont Junior High School, Belmont, Mass.
Walter T. Durnan, South Boston High School, South Boston, Mass.
John C. Hall, Newton High School, Newtonville, Mass.

William D. Munro, Berkeley Preparatory School, Boston, Mass.
Earl H. Ordway, Lasell Junior College, Auburndale, Mass.
Herbert H. Palmer, Perley High School, Georgetown, Mass.
Floyd E. Somerville, Newton High School, Newtonville, Mass.
Albert Thorndike, Milton Academy, Milton, Mass.
Alfred C .Webber, Brookline High School, Brookline, Mass.

The following were elected associate members;
Richard F. O'Neil, Visual Education Service, Boston, Mass.
Harold I. Thompson, Chelsea Senior High School, Chelsea, Mass.

The Association passed a resolution and vote of recognition in memory of Mr. Wallace E. Richmond, a Past-President, who died November 20, 1937. It was voted that a note of sympathy be sent to Mrs. Richmond. Mr. Richmond joined the Association in 1910 and was a member for twenty-six years. He was Vice-President of the Association in 1918, and again in 1920, and President in 1925–26.

A letter from the American Science Teachers Association inviting the E. A. P. T. to affiliate with that organization was introduced. Mr. Le-Sourd, of Milton Academy described the American Science Teachers Association as a clearing house for science teachers, saying that there is no one body that can speak for the science teachers in America, and that the A. S. T. A. aims to do so, and to put the various science organizations in touch with each other. He felt that the E. A. P. T., since it may be called the parent organization, should be represented. Affiliation does not affect the independent status of the affiliating bodies. It was voted to join.

A trip to the Massachusetts Television Institute was arranged for January 22.

REPORT OF NEW APPARATUS COMMITTEE

Mr. Hollis D. Hatch

Chairman, English High School, Boston, Mass.

Dr. Andrew Longacre of Phillips Exeter Academy presented the first part of the report.

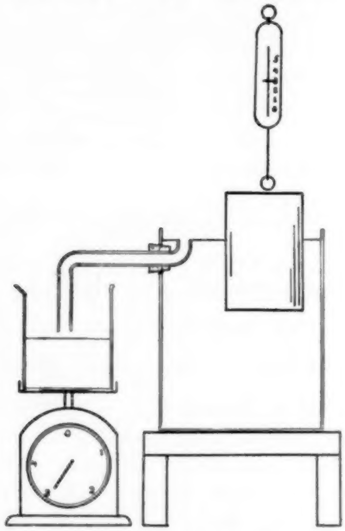
Ladies and Gentlemen:

I should like to present three demonstrations which are not usually found in the literature and which we, at Exeter, feel are distinct aids in "driving home" their respective points in a straightforward, simple manner.

The first is another arrangement to show Archimedes' Principle. It is adapted, we hope with improvements, from a note by R. Hitchcock in the March 1935 issue of the *School Science Review*. As you see, it consists of an overflow vessel, a catch bucket, and an object to be immersed. The catch bucket is on a dial balance, which has had its scale adjusted to read zero when the bucket is empty. The object hangs from a spring balance, which in turn is suspended from a Chinese Capstan. The capstan provides an excellent means for lowering the object gradually into the water. Since it is desired to show the loss in weight of the object when in water, an auxiliary scale is provided for the spring balance. It has its zero at the bottom and reads upward. It is fastened to the balance with its zero opposite the weight of the object. Thus the buoyant force will be indicated directly. The object is lowered a short way into the water. A loss in weight is immediately recorded on the scale of the spring balance. The displaced water flows over into the beaker, and the dial balance records

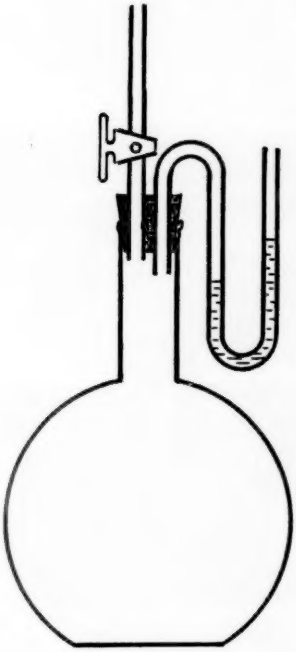
its weight. These are identical. Further lowering increases the buoyant force and increases the displaced water. The two balances both show the same readings at any instant. Those readings keep increasing until the block is submerged. Perhaps it should be noted that the object is a piece of common brick that has been painted with quick-drying lacquer. It has a specific gravity small enough so that the buoyant force is a rather large portion of its own weight.

We use this as a demonstration in our weekly science lectures. It does not supplant the classroom work with the cylinder and bucket nor the laboratory work with the overflow can. Its simultaneous double measurement, of the buoyant force and of the weight of the displaced water, emphasizes Archimedes' Principle without the confusion of specific gravity. It shows what most demonstrations fail to show, the immediate development of a buoyant force as soon as any of the object enters the water. The mechanism of floating follows without demonstration. Thus we emphasize Archimedes' Principle in its broadest form—an object *in* a liquid is buoyed up by a force equal to the weight of the displaced liquid.



The next demonstration I should like to show you represents our endeavor to put greater reality into the concept of vapor pressure. As you see, the apparatus consists of a 500 cc. flask fitted with a two-hole stopper. A stopcock with a long upper arm leads through one opening in the stopper, and an s-shaped glass tube connects through the other. Leaving the stopcock open, mercury is poured into the s-tube, making of it an open manometer. The levels of the mercury clearly indicate that the pressure inside of the flask is identical with that outside. The stopcock is closed, and the upper arm filled with alcohol. The stopcock is now turned to permit a few drops of alcohol to enter the flask, and again closed. Almost immediately the mercury starts to rise, showing a greater pressure inside of the flask than out. In a moment this increase becomes far in excess of any compression due to the volume occupied by the alcohol. In fact, the amount that went in as shown by the drop in level in the upper arm of the stopcock is greater than the volume increase caused by the lowering of the mercury in the manometer. It is therefore quite evident that some-

thing has come from the alcohol and is adding to the pressure in the vessel. It is the pressure of the alcohol vapor. Thus the pressure on the walls of the vessel is partly that due to air and partly that due to alcohol vapor. We define the vapor pressure as that pressure on the walls of a vessel or any object due to vapor molecules. It is a distinct and independent pressure added to the pressure of the air molecules. Quite obviously this demonstration may also be used to illustrate Dalton's law of partial pressures.



The third demonstration developed from three causes: (1) a recent college board question concerning the maximum altitudes of three types of balloons, (2) the interest in the stratosphere flights, intensified by a member of our department's interest in cosmic rays, and (3) a general desire to do a better job with balloons than gas-filled soap bubbles, even though igniting them always interests the audience. The problem of putting on the ascension of a balloon centered around finding a suitable material for the envelope. In a hurry, one of those transparent raincoats was bought for one dollar, cut apart at the seams, a pattern computed, and the segments cut. These were treated with rubber cement for a quarter of an inch around all edges, and then, putting two edges together, they were stitched on a sewing machine.

Subsequent investigation revealed that the material of those raincoats is Pliofilm, made by the Goodyear Company at Akron, Ohio. They reported having used the material for some balloons for Dr. Compton the previous summer and having used the same technique for joining the segments.

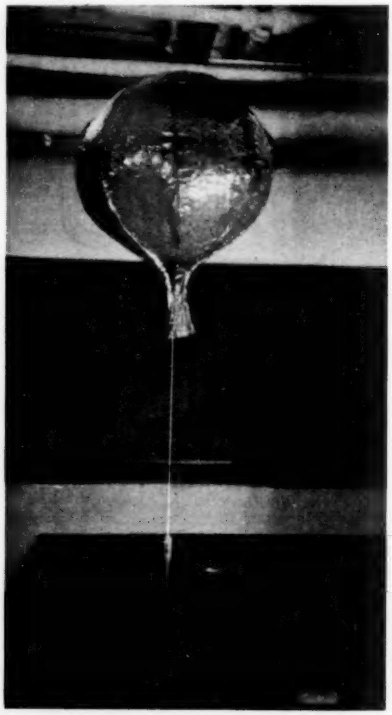
While the material is very flexible, the size of this balloon gives it such a rigidity that the hydrogen needs aid in pushing it out to shape.

The formula for the segment is

$$y^2 = R \tan\left(\frac{180°}{n}\right)\cos\left(\frac{360°X}{2\pi R}\right).$$

A quarter segment was plotted for $R=10''$ and $n=8$. From this the pattern of a whole segment was drawn and cut. A 2-inch strip 7 inches long was glued to one end of the segment to make the appendage.

The balloon has been made to lift 30 grams, which is 60% of its theoretical value. As it floats up off of the tube through which it is filled with hydrogen, it generally finds its level below the ceiling. The density of the air near the ceiling in a room is less both because of decreased pressure and because it is warmer.



Its most instructive use came when some advanced students used it to measure diffusion. The open appendage permits a continuous loss of hydrogen at a rate depending upon the quantity inside. The buoyancy is also proportional to the hydrogen inside. Filled with hydrogen, the balloon was anchored to a 100-gram weight on the left pan of a pan balance, and equilibrium was established by weights on the right pan. The difference between 100 grams and the weights on the right pan was the buoyance. This was measured every 15 minutes. A graph was prepared showing the decrease, and it compared remarkably with the logarithmic curve. It took 6 hours for the lift to reduce from 23 grams to zero, or the buoyance from 57 to 32, 32 grams being the weight of the envelope.

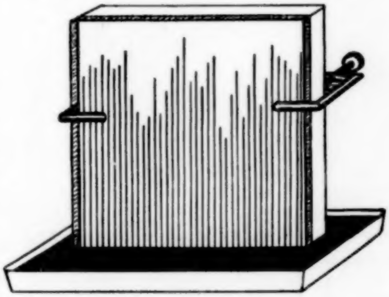
Hoping that you have found these demonstrations interesting and that in some way they may aid you with your problems, I thank you for your very kind attention.

Mr. Drury of Middlesex School, Concord, Mass., demonstrated the following:

(A) *To show capillarity*

One of the square white "vitrolite" plates used on platform balances makes an excellent back plate for the demonstration of the capillary rise between two plates held together at a small angle. The effect can be seen more plainly than when transparent glass is used, especially when the liquid itself is black or dark-colored. Dark blue ink is recommended.

(A) Makes capillary action plainly visible.
The ribbed side of a white "Vitrolite" slab from a platform balance is held by screw clamps against a piece of window glass, and the two set in a dish of ink.



The fine ribs on the back of these plates make an even more striking device for showing capillary rise. If a piece of window glass is held flat against the ribbed side and the lower edge put in colored liquid with the ribs vertical, the movement of the liquid can be seen from a considerable distance. Pinching the plates together at any point produces an immediate and visible climb of the liquid there. The plates should be cleaned and dried before use. Plates having 20 ribs to the inch show a rise up to five inches along many of the grooves.

A pair of open-side screw clamps make an effective method of clamping the plates together.

Pieces of this flat white glass can be obtained from the Vitrolite Const. Co. of N. E., 244 Washington St., Boston. (Specify fine ribs on the back.)

(B) *To illustrate trajectory*

This piece of equipment, adapted from a foreign model, is easy to make, and shows plainly and quickly the paths of projectiles started at varying angles of elevation.

A Boyle's Law stand has been used practically unchanged. The meter stick on it has been retained, and a $\frac{3}{4}$-inch ball hung from a screw-eye at every 10-centimeter mark. The lengths of the suspending cords increase in the ratio of the distances covered by a freely falling body in successive seconds: 1, 4, 9, 16, 25, etc.

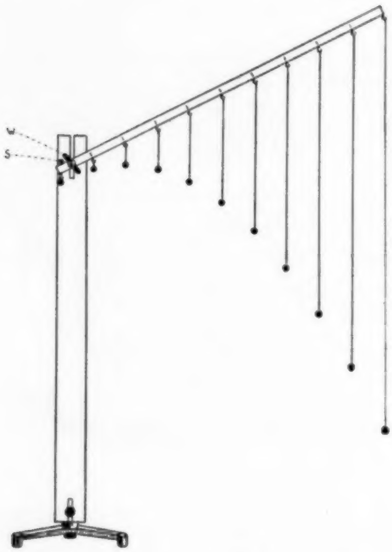
After a trial of various objects for the "projectiles," bright red spherical buttons (cherries) were chosen because they show up so plainly. They are also easy to tie on and adjust.

(C) *To show Archimedes' Principle*

In place of the turned brass cylinder and cup often used for proving Archimedes' Principle on a small scale, an ordinary #6 dry cell and its cardboard case will be found highly satisfactory.

The cardboard case is made watertight by dipping it in paraffin, making sure that the lower joint is well covered.

The outer terminal of the metal cell is then removed by melting its solder, but the contents of the cell are left untouched, and the indentations at the top and bottom of the metal case are filled out with plaster of Paris to give the cylinder flat ends.

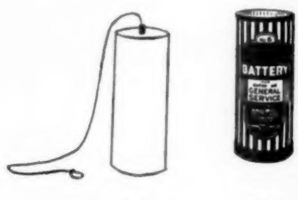


(B) Boyle's Law stand to show trajectory of projectiles. Balls suspended at regular intervals from the meter stick trace the paths of projectiles fired at different angles of elevation. By loosening the wing-nut (W) the position of the stick can be changed.

The protruding screw (S) serves as a stop to keep the stick from falling down under its own leverage when clamped at the desired angle.

In use, the two parts can be counterbalanced on one pan of a sturdy platform balance (they weigh about a kilogram) and then the metal cell suspended in water from beneath the same pan. The center terminal provides a knob for tying the supporting string. The lifting effect of the displaced water can be neutralized, as we know, by adding an equal volume of water, or just enough to fill the cardboard case.

The advantages of large size and visibility make this a useful variation over the small brass or glass cup and cylinder, although the latter when used with a sensitive balance provide a more delicate test. If carefully prepared, however, the dry cell method will also give very close results.



(a) (b)

(C) Large-scale cylinder and cup for Archimedes' Principle. (a) Inside metal case of No. 6 dry cell, with outer terminal unsoldered, and both ends filled out flush with plaster of Paris. (b) Cardboard case to fit this, dipped in paraffin so as to hold water.

"Inaudible" dog whistle

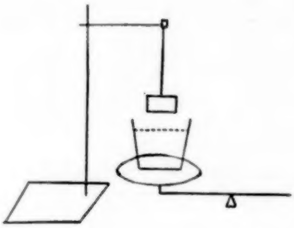
Various large sporting goods and hardware stores now sell the "Acme Silent Dog Whistle." This English product can be tuned, like the very

expensive "Galton whistles," to a high pitch which is almost if not entirely inaudible to human ears. Dogs, on the other hand, can still hear the sounds, and can be trained to respond to them even as far as 200 yards away.

These whistles give a practical angle to the textbook discussions on the limits of hearing, and one of them makes a stimulating little piece of science equipment.

Mr. Hatch then explained a new technique in determining specific gravity:

Specific Gravity is commonly determined from an object's loss of weight in water. This is easily but not accurately found with a spring balance. The beam balance is more accurate; most of them have a hook on the under side from which an object can be hung. A more convenient use of the beam balance is as follows:



Place a beaker or tumbler of water on a beam balance and weigh it. Then hang a solid from a ring on a ring stand and lower it into the water. The tumbler of water now weighs *more*, although the solid is nowhere touching the tumbler. This is because the water exerts a buoyant force on the solid but for every action there is a reaction. Thus while there is an up force on the solid, we get an equal down force against the balance. In other words the gain in weight of the tumbler is the buoyant force on the solid.

I call this method, Specific Gravity by Reaction.

REPORT OF COMMITTEE ON MAGAZINE LITERATURE AND NEW BOOKS

MR. CHARLES B. HARRINGTON, *Chairman, Newton High School*
PROF. CHARLES W. BANKS, *Wentworth Institute*
MR. THOMAS C. BAILEY, *Hartford Public High School*

NEW BOOKS

Electrical Occupations, by Lee M. Klinefelter. Dutton, publishers. 227 pages. Illustrations. $2.00

The book describes the scope of electrical engineering and should be very useful in educational guidance. It is written in simple language and a conversational style.

Sound, by Arthur Taber Jones. Van Nostrand, publisher. 450 pages. Illustrations. $3.75.

This, a textbook on the subject of sound, without doubt is too difficult for high school pupils, but it might be profitably used as a reference book on the fascinating study of sound.

Workbook and Laboratory Manual in Physics, by Turner, Culver, and Masson
College Entrance Book Co. 288 pages. $0.72.

This manual divides the work into 16 units, each unit containing ques-

tions to be answered or filled in by the pupils. The questions are followed by simple experiments, all planned to teach the physical principles of the unit. There are 71 experiments, 36 of which are marked as fundamental to a minimum course.

The choice however will not meet the approval or the requirements of all physics teachers, although they all appear to be interesting and worthwhile.

At the end of each unit there is an achievement test for the pupil. This ought to be of great value to both the teacher and the pupil.

MAGAZINE LITERATURE

"Heat Transfer Efficiency of Range Units," *Electrical Engineering*, Aug., 1937, p. 953–960.

This article is a very interesting and enlightening discussion of tests of four electric ranges for their efficiency. The tests being conducted by W. James Walsh, an electrical engineer. The methods of testing are fully described, the results obtained and recommendations made for improving the heating units on electric ranges. The article contains many photographs, graphs, charts, and tables, all of which give the impression of the care and accuracy of the results obtained.

"X-Rays Kill Cells by Suffocation," *Science News Letters*, Sept. 25, 1937.

This article is an excellent discussion of X-Rays and their uses in medicine.

"The Miracle of Talking by Telephone," *National Geographic Magazine*, Oct. 1937, p. 395–433.

This is a wonderful article on the telephone, and includes its discovery or invention, beginning with the first crude apparatus up to the present efficient telephone. The pictures are numerous and of great educational value to any person, whether or not he is or has been a student of physics. This article should be read by every physics teacher as it will enlighten him on the telephones, their value, the problems of maintenance, and the great part played by the telephone in the affairs of all nations of the world.

"Movies Have 3 Dimensions in Sound as Well as Sight," *Science News Letter*, Oct. 23, 1937.

Here we have a description of stereophonic film viewed with poloroid glasses, each lens polarized differently results in giving a new depth to the picture.

A new monthly publication, *Current Titles from Engineering Journals*, Edited and published by Arthur Cecil Stern, M. E., M. S., at 928 Broadway, New York should prove to be of great value to science teachers.

It aims to publish the tables of contents of a large number of magazines in the fields of Engineering, Physics, Chemistry and Geology. Among the journals included in this list are the following:

General Science

Am. J. Math.
Am. J. Sci.
Am. Phil. Soc. Proc.
Canadian J. Research (A. & B.)
Franklin Inst. J.
Imperial Inst. Bull.
J. Research
Royal Inst. G. B. Proc.
Royal Soc. Can. Proc.
Wash. Acad. Sci. J.

Chemistry, Physics and Geology

Acoustical Soc. Am. Bull.
Am. Assn. Pet. Geol. Bull.
Am. Chem. Soc. J.
Am. Geophysical Un. Trans.
Am. Physics Teacher
Chem. Soc. J.
Economic Geology
Geol. Soc. Am. Bull.
Geophysics

Ind. & Eng. Chem. (Anal. Ed.)
J. Applied Phys.
J. Chem. Phys.
J. Geology
J. Math. & Phys.
J. Phys. Chem.
J. Sci. Instruments
Opt. Soc. Am. J.
Phys. Rev.
Rev. Mod. Phys.
Rev. Sci. Instruments
Terr. Mag. & Atmos. Elec.

General Engineering

Agricultural Eng.
Ag. Exp. Sta. Record
Am. J. Public Health
Eng. Exp. Sta. Record
Eng. J. (Canada)
Inst. Eng. & Ship. Scot. Trans.
J. Ind. Hygiene
Jun. Inst. Eng. Trans.
N. E. Coast Inst. Eng. Trans.
South Wales Inst. Eng. Proc.
Technology Review.

Civil Engineering

Am. Concrete Inst. J.
Am. Soc. Civ. Eng. Proc.
Am. Water Works Assn. J.
Asphalt Inst. Proc.
Civil Eng.
Concrete Rein. Steel Inst. Proc.
Inst. Civil Eng. J.
Inst. Mun. & County Eng. J.
Inst. Water Eng. Trans.
Planners J.
Public Roads
Reclamation Era
Sewage Works J.
Structural Eng.

Mechanical Engineering

Am. Cer. Soc. Bull.
Am. Cer. Soc. J.
Am. Refractories Inst. Bull.
Am. Soc. Mech. Eng. Trans.
Automobile Eng.
Can. Pulp & Paper Assn. Proc.
Gas J.
Heating, Piping & Air Cond.
Ice & Refrigeration
Illum. Eng. Soc. Trans.
Inst. Transport J.
Inst. Auto. Eng. Proc.
Inst. H. & V. Eng. J.
Inst. Mech. Eng. Proc.
Inst. Production Eng. J.
J. Aeronautical Sci.
J. Applied Mechanics
Mech. Eng.
Paper Trade J.
Refrig. Eng.
SAE J.
Soc. Glass Tech. J.
Soc. Motion Picture Eng. J.
Soc. Nav. Arch. & Mar. Eng. Proc.
Tool Eng.
Welding J.

Chemical Engineering

Am. Dyestuffs Rep.
Am. Inst. Chem. Eng. Trans.
Chem. & Ind.
Electrochem. Soc. Trans.
Ind. & Eng. Chem.
Inst. Brewing J.
Inst. Plastics Ind. J.
Inst. Pet. Tech. J.
Soc. Chem. Ind. J.
Soc. Dyers & Col. J.

Electrical Engineering

Bell Labs. Record
Bell System Tech. J.
Can. Elec. Assn. Proc.
Edison Elec. Inst. Bull.
Elec. Eng.
Elec. Communication
Gen. Elec. Rev.
Inst. Radio Eng. Proc.
R. C. A. Rev.

Mining and Metallurgical Engineering

Am. Foundry. Assn. Trans.
Am. Inst. Min. & Met. Eng. Trans.
Am. Iron & Steel Inst. Proc.
Copper & Brass Res. Assn. Bull.
Eng. Soc. Western Pa. Proc.
Iron & Steel Eng.
Metals Technology
Mining Technology
Min. & Met.

SCIENCE EDUCATION FOR THE MASSES

By Mr. Floyd E. Somerville, *Newton High School*

We are beginning to realize that education in Science must take into account not only the leaders of the coming generations but also those who are to follow. Education for the masses is perhaps more important in some respects than for future leaders. The latter have inherent ability. They learn more easily and thoroughly than average students.

Our textbooks of the past have been written for preparation in leadership. Books of such temper must continue to be written but they should not be used as a basis for education of the masses. The realization of this fact has come to us as a result of recent influx in our secondary school population. This growth has given us average students who must prepare to live an average life.

Following this lead, we at Newton are attempting revisions not only in Science but in all courses which we feel will be of functional value to these people. We are now at a stage of development when it would be unwise to make conclusive statements. With this important fact in mind, our current aims and objectives in Science may be briefly stated as follows:

1. *Fundamental aim*—To provide a course integrated in three years which will train the average student of today to follow intelligent democratic leadership. This means enlightened consumption of the world's goods and appliances.
2. *Related aims*—The promotion of healthy mental attitudes and physical well-being by: intelligent observation, open-mindedness, confidence, inspiration, and recreation.

We feel that the tenth year work should consist of Health Science, with special attention given to sane living.

The science of the eleventh year should be built around Chemistry. The functional must not completely bury the fundamental principles of Chemistry.

The application of physical principles to functional values should be the aim of twelfth year science. The approach to all fundamental and related physical principles should be through avenues of common things such as the automobile, the train, the airplane, the ship, the telephone, the radio and the home.

The material should not be merely descriptive, but should contain vital physical principles. Such principles should be treated rather intensively if they have direct bearing on average human affairs.

Practically every physical fact or principle can be applied as an explanation to questions or problems such a treatment is sure to arouse.

The text, *Senior Science* by Bush, Ptacek, Kovats, is a well written descriptive course for those students without prospect of future education in science. It is not meant to replace the usual courses offered in High School Physics and Chemistry. Its fundamental aim seems to be special attention to the social implications of science rather than the intensive treatment of fundamental principles of a scientific nature.

The publishers, American Book Company, have done a very fine piece of work in the preparation of the book. Good binding, strong paper without objectional gloss, large well spaced print, and large clear illustrations and diagrams are among the fine features.

The content is suggested by the Unit Titles, which are as follows:

1. Water: The Life Blood of the World
2. Fire: Its Wonders and Dangers
3. Fuels: Comfort and Convenience Makers

4. Weather and Air: Our Constant Companions
5. Foods and Medicine: Facts and Fads about Life and Health
6. Textiles: Dressing up the World
7. Building Materials: The Life of the Home
8. Home Equipment: Daily Tasks Made Easier
9. Transportation: Everybody Going Places
10. Safety: Accident Prevention Becoming Scientific

As the title suggests the book is meant for a one year course in science. It would seem, as the table of contents show, that such an expanse of material is altogether too extensive for anything like adequate treatment in one year. Following the general trend of a three year integrated science course for senior high school students of average ability, it would seem far more advisable to divide the book into two parts, to be given during each of the last two school years. Such a division would enable the authors to get a bit beneath the skin of the popular in science.

A reading course in science leaves too many questions of functional value unanswered. Under the plan of such a book the authors are forced to neglect intensive treatment of important fundamental principles of science. It is necessary to neglect groundwork which is imperative to a clear understanding of important related factors. Terms and principles can not be sufficiently defined. Above all it becomes necessary to almcst completely neglect demonstration by the teacher or students. It would seem that this is a serious defect in any course in Science. Such a practice on the part of authors places their work in the field of Social Studies rather than in that of True Science. There is nothing wrong with the subject matter of science. It is the approach that needs study. These authors, it would seem have the correct approach as to the selection of material, but they have been forced to neglect the scientific treatment. For example, experience has shown that students of below average interests and ability gain a much more stable understanding of safety in motor vehicle operation when they have complete definitions of centrifugal force and momentum in mind. Clear, simple demonstration should fix in their minds the relation of such factors as; skidding, tipping, speed, weight, tiretread width, wheel base width, and center of gravity. A complete study of friction as applied to this problem should be given.

It would seem that these items merit considerable allotment of time because of their functional value in the business of present day living. Perhaps the authors had this fact in mind. Perhaps they intended the class room teacher to be the agent in bringing about the fact that science (functional science) is not a scratch on the surface of things. But is it not a mistake to assume that all teachers are properly fitted to bridge this gap?

If this text is to be used, it is suggested that it be used as the basis of a two year course to be given in the last two years. Opinion differs as to the use of a book which is so consolidated. Some feel that there is a definite loss of teaching power by placing 12th year work in the hands of 11th year students. This is especially true when the students are of below average ability. When the same book is given to them for their last year's work they have dulled the edge of interest by previous contacts. Some have for this reason, found it difficult to get off to the good start which is so important in successful teaching.

As a final word, let it be said that these men have dared to make the step which we all feel is on the right track and in the right direction. Let's take off our hats to these gentlemen!

Mr. Charles B. Harrington mentioned three periodicals of value to

Physics teachers. They were *Science Digest*, *Science News Letter*, and the new periodical, *Current Titles from Engineering Journals*.

DEMONSTRATION "SOME LABORATORY USES OF COMPRESSED AIR AND THE AMPLIFIER"

By Mr. Homer W. LeSourd, *Milton Academy*

Thirty Demonstrations in Thirty Minutes

USES FOR COMPRESSED AIR

Heat Experiments

Cooling by Expansion, Cloud-making

Sound Experiments

The Siren
Galton's Whistle
Vocal Cords
Beats from Resonating Columns (2 bottles of equal size but one containing a little water)

Pressure Experiments

Water Pressure Gauge
Principle of Air Brake, etc.
Principle of Lawn Sprinkler and Rockets
Buoyancy of a Balloon
The Cartesian Diver
Boyle's Law Apparatus

Bernoulli Experiments

Glass Tube to show Relative Pressures
Ball in Stream of Air
Ball in Funnel
Candle Flame in Funnel
Cardboard on Disk

USES FOR THE AMPLIFIER

The String Telephone
Interference with a Tuning Fork
Resonance of an Air Column
Types of Microphone
- Razor Blades
- Carbon Rods
- Carbon Particles
- The Stethoscope
- Velocity Microphone
- Receiver as a Transmitter
- Replica of Bell's first instrument

Low Frequency Tones
Principle of Sound on Film
Principle of Hammond Organ
Record to show the Effect of Harmonics on Quality.

Mr. LeSourd made the demonstrations with brief comments. The demonstration included many ingenious experiments which can be made with simple materials, and which suggest many uses for compressed air and the amplifier in demonstration work.

TEACHING DEMONSTRATION WITH A CLASS

By Mr. Burton L. Cushing

Mr. Burton L. Cushing, Head of the Science Dep't. at the East Boston High School and Special Lecturer in The Teaching of Physics at the Harvard Graduate School of Education gave a teaching demonstration with a class of 12 boys from the Milton Academy and the Milton High School. The subject of Heat was introduced with the topic of Temperature and Expansion. The class had not had the subject before in their own classes. First the boys answered some introductory questions at the beginning of the Chapter on Temperature and Expansion in Stewart, Cushing and Towne's *Physics for Secondary Schools.* Then answers showed that the boys had some general ideas about the subject but did not really understand it in a technical or scientific sense. Then the teacher presented demonstrations showing the expansion of solids, liquids, and gases, at the same time asking questions of the class to get them to explain and discuss what they saw, and also to get them to give practical examples of the principles being illustrated. He added enough information to that volunteered by the boys so that at the end of the class the principle had been well enough taught so that the pupils should be able to understand the home lesson assignment for the next day which was pp. 207–216 with the 7 problems on p. 213 in the above mentioned text.

The principles of teaching brought out by the demonstration were: first, the use of introductory questions to stimulate interest; second, presenting the topic in class before an assignment had been given from the text; third, an experimental demonstration as an introduction to a new topic; fourth, participation of the class in developing the principle; and fifth a text book assignment as a means of fixing the principle and its applications in the minds of the pupils.

The presentation was well received by the members present which indicates that a repetition of this experiment by some other members of the association at a later meeting might be profitable.

The members of the Association were guests of Milton Academy at luncheon. After a social hour they were greeted by Mr. W. L. W. Field, Headmaster of Milton Academy. He gave an interesting account of Mr. Lee, the founder of the study of physics there forty-five years ago, of his work, and the tradition he established and which still lives. He ended his talk with the advice to maintain the simple quiet attitude of inquiry, and to avoid the mystifying or conjurors attitude.

SCIENCE IN EDUCATION, FROM THE VIEWPOINT OF BENJAMIN FRANKLIN

Address by Dr. Karl T. Compton, *President of the Massachusetts Institute of Technology*

It occurred to me, in accepting your invitation this afternoon, that it might be interesting and appropriate to discuss some aspects of Benjamin Franklin's philosophy of education, as I recently had occasion to review them in connection with the sesqui-centennial of Franklin and Marshall College this Fall. For Franklin was America's first great scientist; he was a product of New England; his originality, ingenuity and sound common sense give him a unique position in the history of American science.

No statement, to my way of thinking, could be more expressive of Benjamin Franklin's philosophy of education than that which is taken from the petition that originally requested the granting of a charter for the establishment of Franklin and Marshall College. This petition expressed "conviction of the necessity of diffusing knowledge through every part of the state, in order to preserve our present republican system of government, as well as to promote those improvements in the arts and sciences which alone render nations respectable, great and happy."

Just as a preacher commonly uses a text, either as an authority for something which he wants to say, or to suggest to his mind some line of thought that may be explored with profit to his hearers, so it occurred to me that I might discover among the numerous writings of Benjamin Franklin some suitable basis for my remarks. Explaining this to our librarian, I asked him to send me a couple of good books on Franklin's life and writings. He sent me six large books which I read with fascination and profit, but in none of them could I find any explicit statement by Franklin on the social values of science or on the rôle of science in education.

This dearth of statements about science in education on the part of one who had such an absorbing and productive interest in science and who was so fond of giving advice and recipes on the subject of self-improvement, was a decided surprise to me. It is evident, however, that Franklin's interest in science was *in science* and not in talking or philosophizing about it. And here is a very important point: To Franklin, interest in science seemed so natural that he felt no need to argue it; its practical use was so apparent that he did not have to defend it. He simply did his scientific work and the results themselves were the most eloquent demonstration of its import.

The only clues which my reading gave me regarding Franklin's ideas about science in a school curriculum were of an indirect nature. For example, he did not approve of the teaching of Latin or Greek,—not because he disapproved of them per se, but because he believed the time could be spent to better educational advantage on other subjects. When, in 1743, he drafted a plan for establishing an academy in Philadelphia,—later to become the University of Pennsylvania,—he described "a house in a high and dry situation, not far from a river, having a garden, orchard, meadow and a field or two, a library and an equipment of scientific apparatus; the scholars were to live plainly and temperately, and to be frequently exercised in running, leaping, wrestling and swimming. As to their studies, it would be well if they were taught *everything* that is useful and *everything* that is ornamental. But art is long and their time is short. It is therefore proposed that they learn those things that are likely to be *most* useful and *most* ornamental, regard being had for the several professions for which they are intended." At this time Franklin urged no one special feature of the curriculum except that it should give training in the use of the English language. But all through his connection with the academy, he struggled

to prevent his "useful" studies from being stifled by the weight and prestige of the classical studies. In this connection he wrote:

"There is in mankind an unaccountable prejudice in favor of ancient customs and habitudes, which inclines to a continuance of them after the circumstances which formerly made them useful cease to exist. A multitude of instances might be given, but it may suffice to mention one. Hats were once thought a useful part of dress; they kept the head warm and screened it from the violent impressions of the sun's rays, and from the rain, snow, hail, etc.

"Gradually, however, as the wearing of wigs and hair nicely dressed prevailed, the putting on of hats was disused by genteel people, lest the curious arrangements of the curls and powdering should be disordered, and umbrellas began to supply their place; yet still our considering the hat as a part of the dress continues so far to prevail that a man of fashion is not thought dressed without having one, or something like one, about him, which he carries (chapeau bras, which means) under his arm. So that there are a multitude of the politer people in all the courts in capital cities of Europe who have never, nor their fathers before them, worn a hat otherwise than as a chapeau bras, though the utility of such a mode of wearing is by no means apparent, and is attended not only with some expense but with a degree of constant trouble.

"The still prevailing custom of having schools for teaching generally our children in these days the Latin and Greek languages I consider therefore in no other light than as the chapeau bras of modern literature."

Franklin had no patience with the practice of sending children to college for social prestige rather than intellectual endeavor, and I suspect that he would, today, advocate rigid entrance requirements, and at the same time would desire colleges of many types to educate different groups for the various objectives which have a proper place in our social order. In reference to high standards Franklin deplored the tendency of "every Peasant, who had the wherewithal, to send one of his children to this famous Place (a college) in which, as most of them consulted their own purses instead of their Children's Capacities, I observed a great many, yea the most part of those who were travelling thither, were little better than Dunces and Blockheads. Many of them from henceforth for want of Patrimony, lived as poor as Church Mice, being unable to dig, ashamed to beg, and to live by their wits was impossible."

So we learn something of Franklin's educational philosophy: he included science among the studies "most useful and most ornamental"; it is evident that he put science alongside of citizenship as the socially most important objectives of the college training; he emphasized the importance of acquiring ability to use effectively the English language; he felt that the dead languages were relatively overemphasized in the schools of his day; and he deplored the wasting of educational facilities upon students of inferior quality.

But, while we learn little about Franklin's ideas of science in education from Franklin's writings, we learn a great deal from his actions. He had a burning curiosity to know the facts and explanations of his environment. He was never so happy as when studying or experimenting on scientific questions. He had an irrepressible urge to turn his scientific knowledge to practical account through inventions. He was so impressed with the social values of these inventions that he refused to accept any financial reward from them, but donated them freely to the public. Franklin's interest in science was, therefore, very direct and very practical.

Perhaps the most comprehensive statement which Franklin made to indicate his range of interests in science and his faith in its practical value to mankind, is found in his plan of 1743 for founding the American Philosophical Society. As I read the following quotation from his prospectus of this society, I would ask you to note that today, nearly 200 years later the same subjects are matters of intense interest in science, industry and agriculture. He specified:

"That the subjects of correspondence be: all new discovered plants, herbs, trees, roots, their virtues, uses, etc.; methods of propagating them, and making such as are useful, but particular to some plantations, more general; improvements of vegetable juices, as ciders, wines, etc.; new methods of curing and preventing diseases; all new-discovered fossils in different countries, as mines, minerals and quarries; new and useful improvements in any branch of mathematics; new discoveries in chemistry, such as improvements in distillation, brewing and assaying of ores; new mechanical inventions for saving labour, as mills and carriages, and for raising and conveying of water, draining of meadows, etc.; all new arts in trades and manufactures—and all philosophical experiments that let light into the nature of things, tend to increase the power of man over matter and multiply the conveniences or pleasures of life."

Not only is this outline of the scope of science as applicable today as it was when Franklin wrote it, but the field appears to be inexhaustible. As he himself said, "The world is daily increasing in experimental knowledge, and let no man flatter the age with pretending that we have arrived at a perfection of our discoveries."

With this perspective of the scope and practical value of science, expressed in Franklin's own words, I would suggest four educational values of science which, severally and together, justify science as an important part of any school curriculum and point the objectives toward which the educational processes should be directed.

(1) First in importance I should put advancement of knowledge. This involves research in the higher stages and study in all stages of education.

But to extol knowledge without exercise of critical judgment as to the relative values of different kinds of knowledge is folly. For, while we admit that all knowledge is desirable, as contrasted with ignorance, yet some categories of knowledge are so much less significant than others, that their pursuit may be the height of foolishness. To know, for example, the num-

bers of times in which each letter of the alphabet occurs in the King James version of the Bible is, except perhaps for a printer, of far less significance than to know the problems confronting our legislatures or the basic principles of electricity.

While Franklin did not limit his interest in science to what was immediately useful, it is evident that he had a profound conviction that accurate knowledge of Nature and of Man, based on observation and experimentation, stood very high in the scale of relative values of knowledge.

Scientific knowledge has had enormous influence on man's cultural and spiritual development,—in his attitude toward his relation to his environment. It has replaced ignorant superstition, in which men could be swayed by fears, with that security and confidence that arise from understanding. "The truth has set men free."

Even in Franklin's time superstitions were rife. When he invented the lightning rod, for protection against the dangers of lightning, and when lightning rods were being installed on many buildings, Franklin and his inventions were vigorously assailed by the clergy as sacrilegious and tempting the wrath of God. For, argued they, was not lightning an instrument of punishment and admonishment in the hands of God,—especially when skilfully dealt upon in their sermons for the purpose of inciting the fear of God in their congregations? These attacks on Franklin lasted for years. In a period of earthquakes in New England, the ministers were not slow to infer this evidence of God's wrath at having his lightning tamed by Franklin's rods.

But not only in the negative field of freeing men from superstitions and fears, whether attached to religions or otherwise, has scientific knowledge helped mankind spiritually: it has had the positive value of orienting him in his environment and showing him, in this environment, the marvelous order and coördination which pervades the infinite complexities of the world. In this way, science has a powerful cultural influence, if we are willing to accept the definition of culture as "sympathetic understanding and appreciation of life."

Life has various aspects, emotional and intellectual. Music hath charms to soothe the savage breast. In literature we have access to the finest thoughts and feelings of mankind. All of these, and religion, have power to bring us a mystical uplift of feeling. All contribute to true culture. Likewise does science. It too expresses symmetry of form and relationship. It too requires imagination. It too interprets life. But in addition it possesses a power and exercises a type of discipline which is unique.

So I would place the advancement of knowledge through science as the most important contribution of science in education, and I would place first the cultural rather than the utilitarian values of this knowledge.

(2) Equal in importance, I would put the intellectual disciplinary value of scientific study and investigation. Franklin himself expressed this very clearly. Replying to a criticism of his theory of waterspouts, he wrote:

"Nothing certainly can be more improving to a Searcher into Nature,

than Objections judiciously made to his Opinions, taken up perhaps too hastily: For such Objections oblige him to restudy the Point, consider every Circumstance carefully, compare Facts, make Experiments, weigh Arguments, and be slow in drawing Conclusions. And hence a sure Advantage results; for he either confirms a Truth, before too lightly supported; or discovers an Error, and receives Instruction from the Objector. In this View I consider the Objections and Remarks you sent me, and thank you for them sincerely."

He describes the true scientific spirit as follows: "I was too easily led into that error by accounts given even in the philosophical books. . . . But men are, in general, such careless observers, that a philosopher cannot be too much on his guard in crediting their relations of things extraordinary, and should never build an hypothesis on anything but clear facts and experiments, or it will be in danger of soon falling . . . like a house of cards."

When some of his electrical experiments led him to distrust some earlier conclusions, he wrote: "If there is no other use discovered of Electricity, this however is something considerable, that it may help to make a vain man humble."

I have always believed that training as a scientist implants in the student certain habits of careful and logical thought that tend to protect him against irrational or emotional action and to improve his judgment and administrative procedures. If this be true, then a strenuous course in science would be good training not only for a future scientist, but also for a future business man or public official. By way of illustration, consider Franklin's description of a Striking Sundial, which reads:

"How to make a Striking Sundial by which not only a man's own family, but all his neighbors for ten miles round, may know what o'clock it is, when the sun shines, without seeing the dial.

"Chuse an open place in your yard or garden, on which the sun may shine all day without any impediment from trees or buildings. On the ground, make out your hour lines . . . taking room enough for the guns. On the line for one o'clock, place one gun; on the two o'clock line two guns, and so of the rest. The guns may all be charged with powder, but ball is unnecessary. Your . . . style must have twelve burning glasses annexed to it, and be so arranged that the sun shining through the glasses, one after the other, shall cause the focus or burning spot to fall on the hour line of one, for example, at one o'clock, and there kindle a train of gunpowder that shall fire one gun. At two o'clock, a focus shall fall on the hour line of two, and kindle another train that shall discharge two guns successively; and so of the rest.

"Note, there must be 78 guns in all. Thirty-two pounders will be best for this use; but 18 pounders may do, and will cost less, as well as use less powder.

"Note also, that the chief expense will be the powder, for the cannons once bought will, with care, last 100 years.

"Note, moreover, that there will be a great saving of powder in cloudy days.

"Kind reader, methinks I hear thee say, that is indeed a good thing to know how the time passes, but this kind of dial, notwithstanding the above mentioned savings, would be very expensive, and the cost greater than the advantage. Thou art wise, my friend, to be so considerate beforehand; some fools would not have found out so much, till they had made the dial and try'd it. . . . Let all such learn that many a private and many a publick project, are like this striking dial, great cost for little profit."

(3) The third educational value of science is its practical utility. Perhaps the practical minded Franklin would have placed this first. Most, though not all, of his scientific work was either stimulated by his desire to accomplish some useful end, or else had a utilitarian by-product. His extensive studies of the flow of air through pipes and past orifices was stimulated by his desire to design a more efficient stove and a convenient system of ventilation. His invention of bifocal spectacles sprang from his own needs. His construction of a naval towing tank, and experiments on the water resistance to the motion of boat models, were stimulated by his interest in promoting canal transportation.

On the other hand his invention of the lightning rod, and of an electrical method of slaughtering poultry and animals so that their meat would be more tender when eaten, were by-products of a long series of investigations on the nature of electricity and of electrical phenomena which he undertook primarily out of pure scientific curiosity and love of experimental research. Similarly his identification and explanation of lead poisoning, his charting of paths of navigation on the Atlantic Ocean to take best advantage of the Gulf Stream and the Trade Winds, his discovery of marsh gas, and his method of calming stormy water by pouring oil on it, all these were the practical by-products of observations and studies which were certainly not undertaken in the beginning with any immediate practical purpose in view.

The practical value of science is no less real today than in Franklin's day; if anything it has been accentuated by such factors as increasing competition and the necessity of using and conserving our natural resources more wisely. Consider the great problems before our nation today, and you will see that many of them are inherently dependent on science for solution. To be sure many issues are political, like the Supreme Court, or the Civil Service, or labor relations; others are financial, like reciprocal tariffs, taxes and stock market regulations. But there is a great group of problems such as employment; hours and wages of labor; conservation and utilization of national resources; protection against hazards of flood, fire, earthquake, wind and drought; development of new uses for farm products; housing; health; and many others, all of which are fundamentally dependent on science for solution.

It is important, for the welfare of the country, that our colleges prepare young men and women with a training in science which will make them

competent to contribute effectively to the solution of these problems. It is equally important that the rank and file of our population, and especially our future political leaders, be given a sufficient understanding of science to enable them to appreciate what science can do and what conditions are prerequisite to its effective operation.

In this altogether inadequate fashion, I have tried to express certain thoughts on science and on education, and to cast these thoughts against the background of our first great American scientist, Benjamin Franklin. Science has a valuable part in education, because it creates knowledge, disciplines the mind and has great utility. You may study it from a sense of duty, because of these three values, or you may study it for fun. I suspect the latter is the real motive power and the former is the excuse behind most real scientists. But, however it is viewed, science seems destined to occupy an increasingly significant place in our educational system. Through it, some will be enabled to add directly to our understanding of the world and our comfort in living. Its students will be better trained to view situations objectively, to draw rational conclusions from observed facts, to plan an intelligent course in the light of these facts and conclusions, and thereby to be safer citizens in our self-regulating society—our democracy.

RESEARCH AT LOW TEMPERATURES

Address by Dr. Harold T. Gerry

The use of low temperatures should not be considered particularly as a field of research in itself but rather as a very valuable tool in tackling many a problem in varied fields of research. It is from this point of view that we in the low temperature laboratory at the Massachusetts Institute of Technology have been spending a large fraction of our time in the last few years in considering the processes of refrigeration. We have been attempting to simplify the production and maintenance of low temperatures in such a manner that any reasonably well financed research laboratory may install facilities for work at low temperatures, if such facilities are advantageous in making further progress on problems already under study.

We might consider briefly a few of the points that make low temperatures useful in a variety of types of research.

Many of the predictions of modern quantum theory and atomic structure can be most satisfactorily checked experimentally at low temperatures. Higher temperature data can often be treated with reasonable accuracy by very simplified theories. At low temperatures, however, these simplified theories will fall down completely, and a good test of the more complicated theory may be made. Consider such a simple phenomenon as coefficient of expansion of a metal. The coefficient of expansion is almost independent of temperature at around room temperature but suddenly starts dropping rapidly somewhat below the ice point and is almost zero by the time one reaches the boiling point of liquid hydrogen.

Again in studying atoms and molecules we may find low temperatures an advantage. At higher temperatures the atoms and molecules are usually, even in crystals, in a constant state of motion due to thermal energy. At low temperatures this thermal motion may become almost negligible in comparison. Consequently, one disturbing factor in the interpretation of measurements may be eliminated.

Some sorts of data, notably specific heats, measured from low temperatures to high temperatures are useful in determining thermodynamic quantities of use at ordinary temperatures. A large and very important fraction of the low temperature work at present in progress in this country is connected with this type of problem. It has many practical applications.

There are many phenomena, occurring only at low temperatures, which are of interest in clarifying our understanding of matter and of assistance in developing new theories which will bring these new phenomena into the same picture with the older ones. Before mentioning a few of these it might be well to orient ourselves somewhat by a brief summary of the temperature scale in the low temperature region. The scale ordinarily used by low temperature workers is the Kelvin scale where

$$T°\text{K} = t°\text{C} + 273.16$$

and 0°K is the lowest possible temperature. On this scale some temperatures are listed below.

The freezing point of water is 273.16°.
The lowest recorded Boston temperature is 246°.
The temperature of dry ice is 195°.
Liquid oxygen boils at 90°.
Liquid nitrogen boils at 77°.
Liquid nitrogen freezes at 63°.
Liquid oxygen freezes at 55°.
Liquid hydrogen boils at 20°.
Liquid hydrogen freezes at 14°.
Liquid helium boils at 4.2°.
Liquid helium transition occurs at 2.2°
Lowest temperatures obtained experimentally occur at about .02°.

We will discuss methods of reaching these temperatures at a later point. Measurements of temperature in this region, except below 1° absolute, are based on gas thermometer measurements which are very cumbersome to use and require lengthy computations in determining any particular temperature. More convenient measuring instruments, such as thermocouples and electrical resistance thermometers or vapor pressure thermometers, may be used after comparing them with a gas thermometer.

One of the most startling of phenomena occurring at low temperatures is that of superconductivity. If, for example, a lead wire is cooled slowly, it gradually decreases in resistance as the temperature drops. At a temperature of 7.2°K, however, the resistance suddenly drops to a value so low that it is impossible to measure it. It has been proved that at 4.2°K

its resistance is less than 10^{-12} of its value at room temperature. If a current is started in a loop of lead wire by means of a magnetic field, it will continue to flow for days without appreciable diminution. There is a limit to the amount of current that the wire can carry, however, due to the magnetic field developed by the current. At any given temperature the superconductivity suddenly disappears at a definite magnetic field strength. Only certain metals and alloys and some chemical compounds show this phenomenon, and in all known cases it occurs below about 10.2°K. No satisfactory theory has been developed as yet for this behavior, but any rigorous theory of metallic conduction must explain this phenomenon.

Another, as yet unexplained, phenomenon is the fact that liquid helium exists in two separate modifications. One modification exists from 2.2°K up to the critical temperature of helium, the other below 2.2°K. The higher temperature form is very similar in properties to other liquids, but the lower temperature form exhibits a number of peculiarities. One of its most extraordinary characteristics is that it has a very high heat conductivity.

In that respect it is much better then either copper or silver which are the two best heat conductors at ordinary temperatures. If one applies heat to any part of the liquid in order to make it boil, no bubbles will arise from the point of heating. All the heat will be conducted to the surface of the liquid, and the evaporation will take place there without the formation of bubbles even though the liquid is very light and mobile. This liquid cannot be frozen to a solid by cooling alone. One can obtain solid helium by the application of pressure but not by any cooling without also applying pressure.

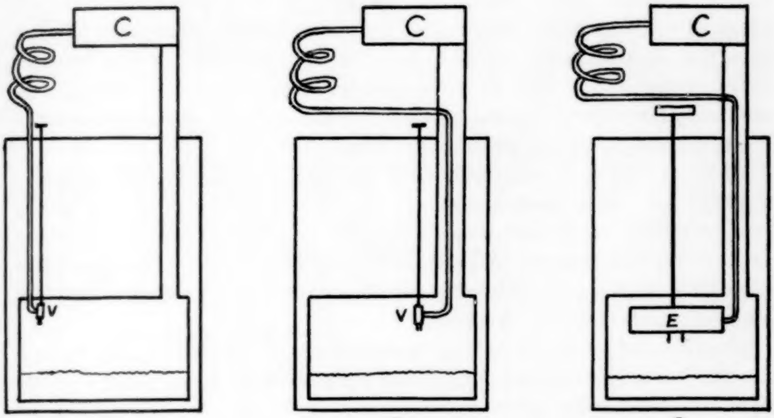
Other peculiarities occur at low temperatures, many of them explainable by theory and others not so explainable. For example, it was predicted theoretically that ordinary hydrogen is made up of two varieties of molecules, or of four if one considers also the small amount of heavy hydrogen present. At low temperatures these two modifications can be separated and show the differences in properties expected.

The most convenient method of obtaining low temperatures is to have available supplies of either liquid air or nitrogen or oxygen, plus liquid hydrogen and liquid helium. With these, temperatures between 1°K and room temperature can be obtained. Liquid air is now available commercially in a great many places so that its production is not particularly essential in the laboratory.

We might consider briefly the various methods of refrigeration and the production of liquified gases.

Fig. 1 shows diagrammatically the ordinary household refrigerator. A compressor *C* compresses low pressure gas to such a pressure that, as it gets cooled in the condenser, liquid forms which flows down through a valve *V* into a low pressure compartment. The liquid vaporizes cooling the insulated space, and the low pressure gas is returned to the compressor. The condenser in this arrangement must be below the critical temperature

of the gas, and the lower temperature is limited by the vapor pressure of the liquid which drops off rapidly as the temperature falls. Some increase in efficiency is obtained if the cold low pressure gas returning to the compressor is used to cool the liquid down as it enters the refrigerator as in Fig. 2. This increase is not sufficient to be worth while in the household refrigerator.



1 2 3

The refrigerator does not completely stop operating, however, if the temperature of the condenser is above the critical temperature, because there is a heat effect on expanding from high pressure gas to low pressure gas above the critical point. This effect decreases gradually and becomes zero at a temperature called the inversion temperature, which may be considerably above the critical point. In other words, we can still use the process for liquefying gases provided the heat interchange between high and low pressure gases is good. This arrangement is the ordinary Joule Thompson liquefier for gases which may be used with any condenser temperatures below the inversion point. The efficiency of liquefaction increases as the temperature of the condenser (now better called a precooler) is decreased. An air liquefier will run with the precooler at room temperature. For liquefying hydrogen the precooler must be around liquid air temperature or preferably at temperatures obtained by pumping liquid air. For helium the precooler must be at liquid hydrogen or preferably pumped liquid hydrogen temperatures. By use of suitable conditions of pressure and suitable precooling temperatures, quite good percentages of the gas passed through may be liquefied.

On the last figure may be seen the introduction of an expansion engine whereby on going from high pressure to low pressure, the gas does work in the engine E which is transmitted outside by a shaft. This increases the cooling effect and gives the best theoretical liquefier. The construction of such engines is very difficult, however, because no lubricant can be used, since all of them freeze at low temperatures. Leakage of gas becomes much

more important at low temperatures. The construction of such liquefiers becomes far more complex than the Joule Thompson liquefier.

Any process, which can be reversed and which, when operated in one direction gives off heat and in the other absorbs heat, can be used for refrigeration. Certain materials, notably charcoal, will pick up considerable quantities of gas giving off heat. This is the characteristic which makes its useful in gas masks. However, the gas can be pumped off from the charcoal with vacuum pumps, and heat is absorbed. This process is, of necessity, intermittent due to the fact that charcoal will not flow through tubes as the liquid does in a refrigerator. The method has certain advantages, however, for certain problems in working in the range between liquid air and liquid helium temperatures.

An intermittent process somewhat analogous to the Joule Thompson liquefier but rather more efficient in the case of helium (and only in the case of helium), is to take a container and load it with high pressure gas at as low a temperature as possible by pumping liquid hydrogen. After thermally isolating it, allow the gas to expand to atmospheric pressure, a large fraction of the gas is liquefied.

By pumping on liquid helium temperatures down to 1°K can be produced. The method of producing lower temperatures cannot involve gases, as helium, the hardest gas to liquefy, has a vapor pressure of about .15 mm. of mercury at 1°K; therefore, gaseous helium cannot exist at that temperature above that pressure. In this region magnetic cooling comes into play. Certain paramagnetic substances will evolve heat on being placed in a strong magnetic field and absorb heat when the magnetic field is removed. By cooling such a substance to about 1° to 2°K with a strong magnetic field on and then cutting off the current in the magnet after isolating the substance thermally, the temperature will drop. It is in this way that temperatures of around .02°K have been reached. At these temperatures the vapor pressure of helium has dropped to the order of magnitude of 10^{-100} millimeters, which means that at that temperature, of necessity, the vacuum in any space is better than is attainable with the best vacuum pumps and, in fact, better than that in interstellar space. As yet, comparatively few experiments have been performed in this region, and there is no way of predicting what future experiments here may uncover in the way of new phenomena.

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or

proposed problems, sent to the Editor should have the author's name introducing the problem or solution *as the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Given the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the ones submitted in the best form will be used.

LATE SOLUTIONS

1514, 1516, 1519. *Charles W. Trigg.*

1516. *Daniel Finkel, New York City.*

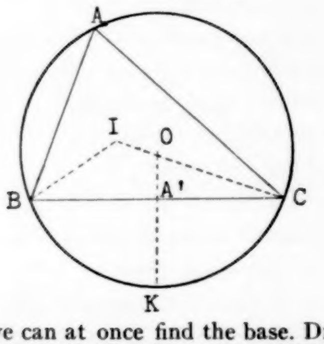
1520. *Proposed by William W. Taylor, Port Arthur, Texas.*

Construct a triangle, given the circumradius, the inradius, and the exradius relative to the base.

Solution by the proposer.

Construction: Let R be the circumradius, r the inradius, r' the exradius relative to the base, a the base, and T_a the perpendicular distance from the circumcenter to the base. From *College Geometry*—Altshiller-Court, page 73 we find

$$T_a = R - \tfrac{1}{2}(r' - r).$$



Having found T_a we can at once find the base. Draw the circle O with radius R and draw any radius OK. Lay off on OK the line $OA' = Ta$ and draw the perpendicular to OK at A' cutting the circle O in B and C. Since R and a are known the vertical angle is at once determined. The incenter I is the intersection of two loci. One is the segment of a circle in which BC as a chord subtends an angle equal to $90° + \tfrac{1}{2}A$. Another is the parallel to BC and at r distance. After locating the incenter I draw the circle with I as a center and radius r. From B and C draw the tangents to circle I and intersecting at A. Triangle ABC is the required triangle.

Solutions were also offered by D. L. MacKay, New York City, and A. D. Johnston, Philadelphia, Pa.

1521. *Proposed by Charles W. Trigg, Cumnock College, Los Angeles.*

What is the smallest two-digit number which when expressed in another scale of notation merely has its digits reversed? What is the smallest three-digit number which behaves similarly?

Solution by the proposer.

Let the numbers be converted from the scales of r and s into the decimal scale, then $ar+b=bs+a$, where if $r<s$ then $a>b$. Furthermore both a and b are less than r and greater than zero, so $r>2$. From the equation $a(r-1)=b(s-1)$, if $r=3$, $a=2$, $b=1$, $s=5$. Hence the required number is 21 (scale of 3) $=12$ (scale of 5).

Similarly, $ar^2+br+c=cs^2+bs+a$, and if $r<s$, $a>c$. Since neither a nor c is zero, and no one of a, b, c is greater than r, then $r>2$. Let $a=K+C$, then $K(r^2-1)=(s-r)[c(s+r)+b]$. When $r=3$ and $s=4$, $8K=7c+b$, so $K=c=b=1$. The desired number is accordingly,

211 (scale of 3) $=112$ (scale of 4).

A solution was also offered by Daniel Finkel, New York City, giving $13_{10}=31_4$ and $371_{10}=173_{16}$ as solutions.

1522. *Proposed by Charles W. Trigg.*

If the sum of the members of each of two number triads is zero, then the sums of the cubes of the triads are in the same ratio as the products of the members.

First Solution by H. R. Mutch.

Let the number triads be a_1, a_2, a_3; b_1, b_2, b_3. Since $a_1+a_2+a_3=0$, they can be used as the roots of a cubic equation

$$x^3+px+q=0.$$

Thence
$$a_1^3+pa_1+q=0$$
$$a_2^3+pa_2+q=0$$
$$a_3^3+pa_3+q=0$$
and adding
$$a_1^3+a_2^3+a_3^3+p(a_1+a_2+a_3)+3q=0$$
or
$$a_1^3+a_2^3+a_3^3=-3q=3a_1a_2a_3.$$
Similarly
$$b_1^3+b_2^3+b_3^3=-3q=3b_1b_2b_3$$
or finally
$$\frac{a_1^3+a_2^3+a_3^3}{b_1^3+b_2^3+b_3^3}=\frac{a_1a_2a_3}{b_1b_2b_3}.$$

Second Solution by Aaron Buchman, Buffalo, N. Y.

Let $a+b+c=0$. Then (1)

$a+b=-c$. Cubing both members (2)

$a^3+3a^2b+3ab^2+b^3=-c^3$. Transposing and factoring (3)

$a^3+b^3+c^3=3ab(a+b)$. Using step (2) (4)

$a^3+b^3+c^3=3abc.$ (5)

Similarly, if $d+e+f=0,$ (6)

$d^3+e^3+f^3=3def$. Dividing (5) by (7) (7)

$$\frac{a^3+b^3+c^3}{d^3+e^3+f^3}=\frac{abc}{def}. \qquad (8)$$

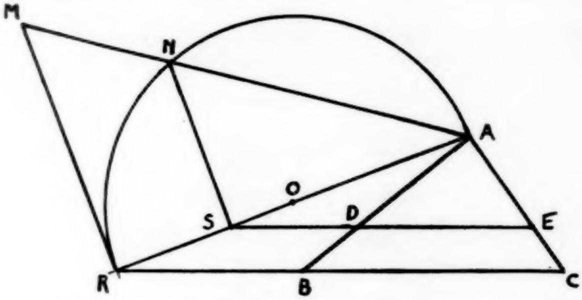
Solutions were also offered by Charles W. Trigg, Los Angeles, Daniel Finkel, New York City and the proposer.

1523. *Proposed by Aaron Buchman, Buffalo, N. Y.*

In triangle ABC, construct a line parallel to BC, intersecting AB and AC at D and E respectively, so that DE is the mean proportional between $(AD+AE)$ and $(DB+EC)$.

First solution by the proposer.

With A as center and $(AB+AC)$ as radius, cut CB extended at R.
Draw AR. Construct $\odot O$ upon AR as diameter.
Construct $MR \perp AR$ and $MR=BC$.



Draw AM cutting circle O at N.
Drop a $\perp$ from N upon AR meeting AR at S.
Through S, construct $SE \| RC$ cutting AB at D and AC at E.
DE is the required line.

Proof.

Since $\quad AR=AB+AC \quad$ and $\quad \dfrac{AS}{AR}=\dfrac{AD}{AB}=\dfrac{AE}{AC}$

it is easily shown that $AS=AD+AE$, $SR=DB+EC$. (1)

Since $\quad MR=BC, \quad$ and $\quad \dfrac{DE}{BC}=\dfrac{NS}{MR} \quad \therefore NS=DE$ (2)

but $\quad \dfrac{AS}{NS}=\dfrac{NS}{SR}$. (3)

Substituting (1) and (2) in (3)

$$\frac{AD+AE}{DE}=\frac{DE}{DB+EC}.$$

Second solution by D. L. MacKay.

Let $\quad AD=x$, $AE=y$. Then $DB=c-x$, $ED=b-y$,

$$DE=\frac{ax}{c}, \quad y=\frac{bx}{c}, \quad AD+AE=x+y=x+\frac{bx}{c}, \quad BD+CE=b+c-x-\frac{bx}{c}$$

If $\quad DE^2=(AD+AE)(BD+CE)$

$$\frac{a^2x^2}{c^2}=\left(x+\frac{bx}{c}\right)\left(b+c-x-\frac{bx}{c}\right)$$

$$a^2x^2=x(b+c)^2(c-x)$$

$$x=0,\quad x=\frac{c(b+c)^2}{a^2+(b+c)^2}\,.$$

The line x is then easily constructed. The solution $x=0$ is not to be rejected for this does not involve division since abstractly we test the proportion by the products of the means and extremes.

A solution was also offered by Charles W. Trigg.

1524. *Proposed by A. R. Haynes, Tacoma, Wash.*

The points $P(13, 10)$, $Q(24, 8)$, $R(29, 23)$, and $S(8, 20)$ are located on the sides AB, BC, CD, and DA, respectively of a square $ABCD$. Find the area of the square and determine the slope of AB.

Solution by Charles W. Trigg, Cumnock College, Los Angeles.

If the points $P(a_i, b_i)$ fall on the sides M_iM_{i+1} of a rectangle, $(i=1, 2, 3, 4)$, and if M_1M_2 has a slope m, then the equations of the sides are.

$$M_1M_2:\quad y-b_1=m(x-a_1),$$

$$M_2M_3:\quad y-b_2=-\frac{1}{m}(x-a_2),$$

$$M_3M_4:\quad y-b_3=m(x-a_3),$$

$$M_4M_1:\quad y-b_4=-\frac{1}{m}(x-a_4).$$

By solving the first two equations simultaneously the coördinates of M_2 are determined, after which the coördinates of the three other vertices may be written by appropriate interchange of subscripts. Thus, the vertices are:

$$M_2\left[\frac{a_1m^2+(b_2-b_1)m+a_2}{m^2+1},\quad \frac{b_2m^2+(a_2-a_1)m+b_1}{m^2+1}\right],$$

$$M_3\left[\frac{a_3m^2+(b_2-b_3)m+a_2}{m^2+1},\quad \frac{b_2m^2+(a_2-a_3)m+b_3}{m^2+1}\right],$$

$$M_4\left[\frac{a_3m^2+(b_4-b_3)m+a_4}{m^2+1},\quad \frac{b_4m^2+(a_4-a_3)m+b_3}{m^2+1}\right],$$

$$M_1\left[\frac{a_1m^2+(b_4-b_1)m+a_4}{m^2+1},\quad \frac{b_4m^2+(a_4-a_1)m+b_1}{m^2+1}\right].$$

Now by application of the distance formula, we have

that
$$\overline{M_2M_3}^2=\frac{[(a_1-a_3)m+(b_3-b_1)]^2}{m^2+1}=\frac{\left[(b_3-b_1)\left(-\frac{1}{m}\right)+(a_3-a_1)\right]^2}{\left(-\frac{1}{m}\right)^2+1},$$

and
$$\overline{M_1M_2}^2=\frac{[(b_2-b\ )m+(a_2-a\ )]^2}{m^2+1}.$$

So if the rectangle is to be a square,

$$(a_1-a_3)m+(b_3-b_1)=\pm\left[(b_2-b_4)m+(a_2-a_4)\right].$$

That is,

$$m=\frac{b_1+a_2-b_3-a_4}{a_1-b_2-a_3+b_4}\ \text{or}\ \frac{a_1-a_2-b_3+a_4}{a_1+b_2-a_3-b_4}\,.$$

So, in general, there are two squares determined by four ordered points. Furthermore, the areas of the two squares may be written in the forms,

$$\overline{M_1M_2}^2=\frac{[(b_2-b_4)(b_1+a_2-b_3-a_4)+(a_2-a_4)(a_1-b_2-a_3+b_4)]^2}{(b_1+a_2-b_3-a_4)^2+(a_1-b_2-a_3+b_4)^2}$$

$$=\frac{(b_1b_2+b_3b_4-b_2b_3-b_4b_1+a_1a_2+a_3a_4-a_2a_3-a_4a_1)^2}{(b_1+a_2-b_3-a_4)^2+(a_1-b_2-a_3+b_4)^2}$$

$$=\frac{\Delta}{(b_1+a_2-b_3-a_4)^2+(a_1-b_2-a_3+b_4)^2}.$$

$$\overline{M_1'M_2'}^2=\frac{[(b_2-b_4)(b_1-a_2-b_3+a_4)+(a_2-a_4)(a_1+b_2-a_3-b_4)]^2}{(b_1-a_2-b_3+a_4)^2+(a_1+b_2-a_3-b_4)^2}$$

$$=\frac{\Delta}{(b_1-a_2-b_3+a_4)^2+(a_1+b_2-a_3-b_4)^2}.$$

Or the formulae for the areas of the squares (and hence of the sides) may be abbreviated as

$$\overline{M_iM_{i+1}}^2=\frac{[(b_{i+1}-b_{i+3})m+(a_{i+1}-a_{i+3})]^2}{m^2+1}, \quad \text{where}$$

m is either of the slopes of M_iM_{i+1} or of $M_i'M_{i+1}'$, depending upon which square is desired. It is evident that if the coördinates of the points be arranged as

$$\begin{matrix} a_1 & a_2 & a_3 & a_4 & a_1 \\ b_1 & b_2 & b_3 & b_4 & b_1 \end{matrix}$$

the slopes and areas may be quickly read off.

In the particular case of the given problem, we find that the slope of AB is $-\frac{3}{4}$ and the area of $ABCD$ is 400; and when the points fall on the sides of the square produced, the slope of $A'B'$ is 29/28 and the area of $A'B'C'D'$ is 80/13.

It will be observed that if the coördinates of the four points are rational, then the area and the slopes of the sides are also rational. Also, if the four points are themselves the vertices of a square, the slopes assume indeterminate forms, so any desired number of squares may be drawn through them.

Solutions were also offered by Aaron Buchman, Buffalo, N. Y., David Rappaport, Chicago, W. R. Warner, and the proposer.

1525. *Proposed by Cecil B. Read, Wichita, Kansas.*

A is the center of a given circle. If B and C are the centers of any two circles tangent externally, but internally tangent to the circle A, show that the perimeter of the triangle ABC is constant.

Solution by Julius H. Hlavaty, New York City.

Let r be the radius of the given circle A.

Let P and Q be the points of tangency of the circle A with circles BC respectively, and R the point of tangency of circles B and C.

Then BRC is a straight line and it is one side of triangle ABC. (Line of centers passes through the point of tangency.)

Similarly ABP and ACQ are straight lines.

$$\begin{aligned}\text{Perimeter of triangle } ABC &= AB+BR+RC+CA\\ &= AB+BP+QC+CA\\ &= AP+QA\\ &= 2r.\end{aligned}$$

Solutions were also offered by H. R. Mutch, Walter R. Warne, New York City, Aaron Buchman, Buffalo, N. Y., Charles W. Trigg, Los Angeles, D. L. MacKay, New York, N. Y., Kenneth P. Carlson, Brule, Nebraska, William W. Taylor, and the proposer.

HIGH SCHOOL HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

No names were reported for this issue.

CORRECTION

In the December issue, page 1131, in problem 1527, change the minus sign preceding the $.2y$ to a plus sign.

PROBLEMS FOR SOLUTION

1538. *Proposed by William W. Taylor.*

Construct a triangle, given the difference of the base angles, the difference of the angles made by the median to the base, and the difference of the exradius relative to the base and the inradius.

1539. *Proposed by Walter R. Warne, New York University.*

Solve for x

$$(1+x+x^2)^2=\frac{a+1}{a-1}(1+x^2+x^4).$$

1540. *Proposed by Aaron Buchman, Buffalo, N. Y.*

Given a variable triangle, ABC, which is similar to a given fixed triangle MNO. If A is fixed, and if B traces a circle, find the locus of C.

1541. *Proposed by Maxwell Reade, Brooklyn, N. Y.*

What is the relation between the sides, and that between the angles of a triangle whose Euler line, the line containing orthocenter, median point, and circumcenter, is parallel to one of the sides of the said triangle?

1542. *Proposed by H. Brandt, Chicago.*

In an isosceles triangle with base $2b$, and altitude a, prove that $WM=MS=\frac{2a}{15}$, where M equals the point of concurrence of the medians; W the point of concurrence of the angle bisectors, and S the point of concurrence of the three perpendicular side-bisectors.

1543. *Proposed by Charles P. Louthan, Columbus, Ohio.*

From the vertex A, of parallelogram $ABCD$ a straight line is drawn cutting BC in E and the diagonal BD in F. If $BE=\frac{BC}{n}$, prove that $BF=\frac{BD}{n+1}$.

When you change address be sure to notify Business Manager W. F. Roecker, 3319 N. 14th Street, Milwaukee, Wis.

SCIENCE QUESTIONS

February, 1938

Conducted by Franklin T. Jones

(Send all communications to Franklin T. Jones, 10109 Wilbur Avenue, S. E. Cleveland, Ohio.)

This department is a forum for discussing Tests, Experiments, Pedagogical Questions, Scientific Happenings. Practical Applications of Scientific Principles, Popular Beliefs and Misapprehensions concerning Scientific Matters, Newspaper Science, Think Problems (mostly scientific), Trick Questions, Borderline Science Questions involving Mathematical Treatment, College Entrance Examination Questions and Problems, Any Problem or Question that will help teachers to make Science Teaching interesting.

The discussion usually takes the Question and Answer Form. Readers, whether teachers and students or outside school walls, are invited to propose Questions or Problems and to answer Problems and Questions proposed by others.

As a Mode of Recognizing contributors, the Guild of Question Raisers and Answerers (GQRA) has been formed and more than 200 contributors have already been admitted to membership. Classes or individuals, may become members by proposing a question or submitting an answer.

JOIN THE GQRA

BRAIN TEASERS

827. *Published by R. B. MacMullin, Puzzle Editor of THE DOUBLE BOND (Western New York) in the August-September, 1937, number (Elected to the GQRA, No. 204), Mathieson Alkali Co., Niagara Falls, New York.*

"Grasp a tennis racket by the handle so that the face is horizontal, with the trademark up. Now toss the racket end over end in the air, taking care not to twist the racket. Try to catch it by the handle after one revolution with the trade mark still up.

"Why do you always fail?"

JINRIKISHA

828. *Proposed by F. H. Wade, Lewis Institute, Chicago, Ill. (Elected to the to the GQRA, No. 205).*

a. "It is said that the jinrikisha, the small two-wheeled hooded Oriental vehicle drawn by a man, was invented by a Yankee sailor from way down East.

"In this machine the weight is in the rear of the wheel. Why?

b. "A jinrikisha has 4 foot wheels and 10 foot thills. The passenger weighs 300 lb. and his center of gravity when in the vehicle is 3 feet in back of the axle.

"If the coolie weighs 125 lb., at what point should he seize the thills for the greatest advantage to all concerned?"

THE WHEELBARROW PROBLEM

829. *Proposed by W. R. Smith, Lewis Institute, Chicago, Ill. (GQRA No. 176).*

"If you wish, you can ask the boys this one:

"Why does an able wheelbarrow man drop his handles as near to the ground as possible when he comes to an obstruction?"

(After solving Question No. 816 Mr. Smith writes:

"This is my analysis of your wheelbarrow problem. I am only an amateur physicist but I am a pretty fair hand with a wheelbarrow."

He then adds the question asked above.

Solutions to 816 were sent in by Mr. Smith and Mr. F. H. Wade. They will be published probably in March, 1938.)

LOOKING FORWARD

803. (1) *What are you going to start this fall that is new, or unusual, or more interesting?*

(2) What do pupils think of the science courses we are giving?

(3) What can "Science Questions" do to be of greater use to a larger number of readers of SCHOOL SCIENCE & MATHEMATICS?

Answer by Sister Mary Stanislaus Costello, R.S.M., (GQRA No. 152) and pupils of Mercy High School, Milwaukee, Wis.

"Once more we offer our contribution—an attempt to answer question 803 of the June issue of SCHOOL SCIENCE AND MATHEMATICS. The second part, however, will be answered by the students. You will find that more than one has responded.

(1) "A new project for the biologists at Mercy High is the making of models from a salt and flour combination. It is truly new, usual, and very interesting. It is my firm opinion that, after having drawn the object, filled it in, and marked the parts, each student understands that particular phase quite well, therefore, I judge it as very practical. After having completed a phase of our subject matter, volunteers brought in models representing what they had learned. We are happy to state that this volunteer work did not and does not rest with the minority. We have on hand now, models of the compound microscope, the typical cell, the resting phase of mitotic division, paramecia amoebas, sponge, hydras, jellyfish, coral, tapeworm, starfish, and two have even attempted all phases of mitotic division. Soon we shall have the trichina, earthworm, and snail; they have been started but are not finished. Some are thinking of making models of the bird on which they shall soon report.

(3) "Science Questions" department is doing good work but, I believe, it can do even more. How? Urge the teachers who should be readers of SCHOOL SCIENCE AND MATHEMATICS to submit not only tests but also projects which they may have found to be interest arousing. In union there is strength. What has aroused students in one class is very well worth while applying in another.

"Enclosed with these answers to one and three are individual student responses to number two of No. 803."

803. (2) *"What I Think About the Science Course," Answer by Mary Doherty, Mercy High School, Milwaukee, Wis. (Elected to the GQRA No. 206).*

"Before I began to study Biology I used to wonder just what kind of a course a Biology student follows. Now I know and I think that the course could not possibly be more unified or interesting. The course began with the study of what biology really is and I think that was the most sensible thing to do. At the beginning of the year we learned some terms and things which we would use during the year. Then we began to study ani-

mals instead of flowers so that we could have the flowers to study when they are in bloom in the spring. By studying animals and flowers first, our bodies will be more easily studied. I hope that our other courses will be adjusted as the Biology course."

Answer by Mary Ellen Hungelman, Mercy High School. (Elected to the GQRA, No. 207).

"Biology, in my opinion, is an eye-opener. It sets before us a better view of man, animals, and plants. It explains their habits of living, of what use they are to each other, and why we should thank the Creator for placing them on the earth as a means of protection and of use for us."

803. (2) *also answered by the following. All from Mercy High School, Milwaukee, Wis. (I regret that space prevents publishing all the answers in full. Editor)*

All elected to the GQRA—

No. 208, Frances Bartlein; No. 209, Patricia Coles; No. 210, Eleanor Kuehn; No. 211, Reta Mary Regent; No. 212, Ruth M. Reis; No. 213, Genevieve Sommer; No. 214, Patsy Tiry.

COLLEGE BOARD PHYSICS—JUNE, 1937

810. —2. A puck weighing 4 ounces is shot forward on ice with a velocity of 60 feet per second, and after 5 seconds has two-thirds its original velocity.

a) Find the constant retarding force which opposes its motion.
b) Find the coefficient of friction between puck and ice.
c) How far will the puck travel before coming to rest?

Solution by Leo E. Chaffin (Elected to the GQRA No. 215) Saint Louis College, Honolulu, T.H.

"I am a fourth year student (senior) at Saint Louis College here in Honolulu. Saint Louis is not, as the name would seem to indicate, a college, but is merely a high school with a name which is a relic of the days when secondary schools were called colleges.

"In this letter I am submitting the answers to the proposed physics questions in the November issue of SCHOOL SCIENCE AND MATHEMATICS. *If they prove satisfactory, I should like to apply for membership in the GQRA.*

"I hope the answers do not reach you too late, since we out here in Hawaii are dependent upon the rather infrequent boats for our mail service."

(a)

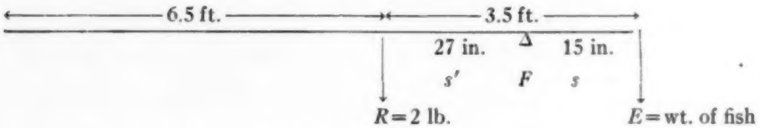
$$\text{Change in velocity} = \text{max. } v - \text{min. } v$$
$$= 60 \text{ ft./sec.} - 40 \text{ ft./sec.}$$
$$= 20 \text{ ft./sec.}$$
$$a = \frac{v}{t}$$
$$= \frac{20 \text{ ft./sec.}}{5 \text{ sec.}} = 4 \text{ ft./}\overline{\text{sec.}}^2$$
$$F = ma$$
$$= \tfrac{1}{4} \text{ lb.} \times 4 \text{ ft./}\overline{\text{sec.}}^2$$
$$= 1 \text{ poundal} = \underline{\underline{\tfrac{1}{2} \text{ oz.}}}, \text{ retarding force}$$

(b)
$$\text{Coefficient of friction} = \frac{F \text{ (due to friction)}}{\text{Weight}}$$
$$= \frac{\frac{1}{2}\text{ oz.}}{4\text{ oz.}} = \frac{1}{8}$$
$$= \underline{\underline{.125}}$$

(c)
$$\text{Time} = \frac{v}{a}$$
$$= \frac{60\text{ ft./sec.}}{4\text{ ft./sec.}^2}$$
$$= 15\text{ sec.}$$
$$\text{Distance} = \tfrac{1}{2}at^2$$
$$= \tfrac{1}{2} \times 4 \times \overline{15}^2$$
$$= \underline{\underline{450\text{ feet.}}}$$

811. —3. A boy has a 2-pound fish pole 10 feet long, the center of gravity of which is 3.5 feet from the thick end. He finds the weight of his string of fish by hanging them from the thick end of the pole and then balancing the pole on a fence rail. He finds that it balances at a point 15 inches from the end. How many pounds of fish has he?

Solution by Leo E. Chaffin (GQRA No. 215). Saint Louis College, Honolulu, T.H.



$$E \times s = R \times s'$$
$$E \times 15 = 2 \times 27$$
$$15E = 54$$
$$E = \frac{54}{15} = 3\ 9/15 = 3\ 3/5$$
$$E = \underline{\underline{3.6\text{ lb.}}},\ \text{wt. of fish.}$$

812—11. A barometer tube 80 centimeters long, filled with air when the barometer reads 75 centimeters, is thrust open-end downward into a lake until water fills 50 centimeters of the tube.

a) How many meters below the surface of the lake is the bottom of the tube?

b) What is the density of the air in the tube under those circumstances, if a liter of air at the surface weighs 1.29 grams?

c) State two principles or laws involved in answering this problem. Assume that the temperature remains constant. The specific gravity of mercury is 13.6.

Solution by Leo E. Chaffin (GQRA No. 215) Saint Louis College, Honolulu, T.H.

(a)
$$\frac{V_1}{V_2}=\frac{P_2}{P_1}$$
$$\frac{80}{50}=\frac{x}{75}$$
$$50x=6000$$
$$x=\frac{6000}{50}=120 \text{ cm. of Hg, pressure beneath } H_2O$$
$$P=hd$$
$$=120\times 13.6=1632 \text{ g}/\overline{\text{cm.}}^2$$
$$1632 \text{ g.}/\overline{\text{cm.}}^2=h\times 1 \text{ g./cc.}$$
$$h=1632 \text{ cm.}=\underline{16.32 \text{ meters}} \text{ beneath surface.}$$

(b)
$$\frac{D_1}{D_2}=\frac{P_1}{P_2}$$
$$\frac{1.29}{x}=\frac{75}{120}$$
$$75x=1.29\times 120$$
$$75x=154.8$$
$$x=\frac{154.8}{75}=2.064 \text{ gram/liter.}$$

(*c*) Two principles involved in this problem are:
(1) Boyle's law: The volumes of a confined body of gas will vary inversely as the pressure, the temperature remaining constant.
(2) Pressure in liquids varies directly as the product of the density of the liquid and the depth of the liquid.

HUDSON MEETING FOR 1938

The Annual Meeting of Northeastern Ohio Science and Mathematics Teachers will be held at Western Reserve Academy, Hudson, Ohio, on Saturday, April 30, 1938.

Dr. J. P. Visscher, Professor of Biology, Western Reserve University, is preparing a fine program.

It will be worth coming a long way to hear.

COME, ON APRIL 30th TO HUDSON, OHIO

SULPHUR

Sulphur, standby spring tonic of the old-time medicine chest, is good for what ails chickenson the outside, it appears from results of experiments conducted by Dr. M. W. Emmel of the Florida Experiment Station.

Dr. Emmel has found that by adding five per cent of sulphur flour to the chickens' laying mash he can rid the birds of external parasites such as lice and sticktight fleas.

Sunshine proved to be a strong auxiliary for the sulphur in the experiments. Fowls kept on the sulphur regimen indoors were relieved of only 25% of their parasites. When sulphur-fed fowls were given liberty to run outdoors, however, they were totally cleared of their infestation.

BOOKS AND PAMPHLETS RECEIVED

Biology, by George William Hunter, Lecturer in Methods of Science Teaching, Department of Education, Claremont Colleges; Herbert Eugene Walter, Professor of Biology, Brown University; and George William Hunter, III, Assistant Professor of Biology, Wesleyan University. Cloth. Pages x+670. 14×22 cm. 1937. American Book Company, 360 North Michigan Avenue, Chicago, Ill. Price $3.75.

The Universe Surveyed, by Harold Richards, Cloth. Pages xvii+721. 14.5×22.5 cm. 1937. D. Van Nostrand Co., Inc., 250 Fourth Avenue, New York, N. Y.

Calculus, by Herman W. March, Professor of Mathematics, University of Wisconsin, and Henry C. Wolff, Professor of Mathematics, Drexel Institute of Technology. Third Edition. Pages xvii+424. 12.5×18.5 cm. 1937. McGraw-Hill Book Company, 330 West 42nd Street, New York, N. Y. Price $2.50.

The Physical Treatises of Pascal, translated by I. H. B. and A. G. H. Spiers with introduction and notes by Frederick Barry. Associate Professor of the History of Science, Columbia University, New York City. Cloth. Pages xxviii+184. 15×23 cm. 1937. Columbia University Press, Columbia University, New York, N. Y. Price $3.25.

Cleanliness and Health, by C. E. Turner, Professor of Biology and Public Health, Massachusetts Institute of Technology, Cambridge, Mass., and George B. Collins, Instructor in Health Education, Rochester Athenaeum and Mechanics Institute, Rochester, N. Y. Third Edition. Cloth. Pages vii+236. 12.5×18.5 cm. 1937. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price 80 cents.

Health, by C. E. Turner, Professor of Biology and Public Health, Massachusetts Institute of Technology, Cambridge, Mass., and George B. Collins, Instructor in Health Education, Rochester Athenaeum and Mechanics Institute, Rochester, N. Y. Third Edition. Cloth. Pages vi+231. 12.5×18.5 cm. 1937. D. C. Heath and Company, 285 Columbus Avenue, Boston, Mass. Price 72 cents.

Report of the President of Columbia University for 1937. Paper, 64 pages. 15×23 cm. Columbia University Press, Morningside Heights, New York.

Proceedings of the Thirty-First Annual Convention of The Association of Life Insurance Presidents held in The Waldorf-Astoria Hotel, New York. Paper. 254 pages. 14×22 cm. 1937. The Association of Life Insurance Presidents, 165 Broadway, New York, N. Y.

Dental Research and Graduate Study Quarterly for the Autumn Quarter, 1937. Volume xxxviii. Number 8. Paper. 31 pages. 15×23 cm. Northwestern University, 301 East Chicago Avenue, Chicago, Illinois.

The Ohio-Mississippi Valley Flood Disaster of 1937. Preliminary Report of Relief Operations of the American Red Cross. Paper. 20 pages. 15.5 ×23.5 cm. The American Red Cross, Washington, D. C.

BOOK REVIEWS

Lecture Experiments in Chemistry, by G. Fowles, M.Sc., A.I.C., F.C.S. First edition. pages xvi+564. 15×21.5×4 cm. 150 figures. Water proof cloth. 1937. $5.00. American Edition by P. Blakiston's Son & Co. Philadelphia.

A really remarkable book and destined to become a classic is this new Chemical Lecture Experiment manual. Containing 547 experiments of every conceivable type, its preparation was a monumental task. Not only

does the book give clear and concise directions for performing the experiments but it also, in many cases, adds excellent teaching material, setting forth the principles involved in the reaction. In many cases there are given alternative experiments, as in the case of molecular weight determinations from vapor density experiments where one may choose from among several modifications of the Victor Meyer apparatus, including one which calls for only a Kjeldahl flask, a cylindrical biscuit tin, some connections and a pair of burettes. An appendix makes a serious study of the various methods of teaching and gives a brief account of the manner of lecturing of a number of famous lecturers. Mechanical aids to lecturing are also discussed. No college lecturer can afford to be without this manual and many high school chemistry teachers could find much material to enrich their courses in its pages as well as some very fine instruction in the art of teaching.

FRANK B. WADE

Demonstrations and Experiments in General Chemistry, by Albert L. Elder, Associate Professor of Chemistry, Syracuse University. Cloth. Pages viii+246. 15×22 cm. Harper and Brothers, New York, N. Y. Price $2.00.

This book will prove a boon to many chemistry teachers who have not yet completed their list of demonstration experiments. The teacher who has his repertoire of experiments will here find many he will want to add to his list. The author has taken into consideration the busy teacher, and so has given with each experiment a detailed list of supplies and equipment needed, as well as a good pen and ink sketch of apparatus, where set-ups are required. An interesting introduction and notes accompany every group of demonstrations.

Equations, stressing electron changes, accompany many of the demonstrations. Enough demonstrations are described to cover every phase of general chemistry. The superior student for whom enough work cannot be found will be stimulated by such experiments as Molecular Bombardment, Pharaoh's Serpent Eggs, Spontaneous Combustion, Explosion in Flour Mills, Volcanic Sulfur, Photography, Blue Prints, The Blast Furnace, Electrolytic White Lead, Sympathetic Inks, Smokes in Chemical Warfare, and Luminescence. A chapter "The Chemist Goes Shopping" gives procedures for testing commodities advertised and used daily. Many good suggestions are given teachers who are thinking of giving chemistry shows and displays. Above all the book is not just another book of experiments.

W. MCCRORY

The Calculus, By Robert D. Carmichael, Professor of Mathematics, University of Illinois, James H. Weaver, Professor of Mathematics, Ohio State University, and Lincoln Lopez, Associate Professor of Mathematics, Ohio State University. Cloth. Pages xvi+384. 14×21 cm. 1937. Ginn and Company, 15 Ashburton Place, Boston, Mass. Price $3.00.

This book is a revision of The Calculus by Carmichael and Weaver published in 1927. Notable changes have been made in the arrangement of the material in order to bring about a closer correlation with the courses in physics, chemistry, mechanics, and other courses required of a student in an engineering school.

Among the changes we find the early introduction of the antiderivative and the definite integral. These concepts are developed in Chapter II immediately after the derivative. This arrangement furnishes a basis for the

study of rectilinear motion. The functions sin x and cos x are differentiated and integrated in Chapter II as a preparation for the study of simple harmonic motion. A chapter on differential equations with applications to problems in physics and engineering has been added.

The exposition is written in a direct and simple style which should encourage the student to learn to read mathematics. The course offers material sufficient for a course of ten hours. By a suitable choice of topics courses of six and eight hours may be arranged.

There are 22 chapters with numerous exercises and problems. Among the problems are many interesting applications.

J. M. KINNEY

The Advancing Front of Science, by George W. Gray. Cloth. Pages xiii+364. 14×23 cm. 1937. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York, N. Y. Price $3.00.

The aim of this book is to report "certain current advances in representative fields of science." The author is an experienced writer for the educated public and a frequent contributor to a number of the best magazines. This book follows his *New World Picture* published a year ago, and gives a most excellent popular report of some of the greatest scientific achievements of recent years. These stories are brought completely up to date; they tell the progress made almost up to the beginning of the present year. The narrative includes the experiments of atomic physicists with high speed projectiles blasting at the nucleus of the atom, the attempts of astronomers to solve the riddle of an apparently expanding universe, the latest work of Tuve and his associates in the Department of Research in Terrestrial Magnetism of the Carnegie Institution, the contributions of Pierce, Fletcher, and Knudsen in establishing a new science of sound. In chemistry Langmuir's study of surface chemistry is the sample described, but the improvement in the properties of glass, the development of alloys, and the discovery of heavy hydrogen receive attention. In biology the story of the search for the source of life leads to Dr. Muller's experiments with fruit flies, the theory of mitogenetic rays, the measurement of the giant molecules of tobacco mozaic and of rabbit warts, and to the theory of the gene as the ultimate unit of life. "Machines Which Imitate Life," "Thinking Machines," "Chemistry and Thinking," and "Can We Live Longer?" are chapter headings which suggest other investigations discussed by the author.

To write understandingly in so many different fields seems beyond the ability of any one man. The preface explains the riddle. The book is not the product of one man. The author, a master of expression, with a broad scientific education, secured the cooperation of many of the specialists whose investigations he describes, thus making possible the best view now available of the present front of science. The last chapter, "The Promise of Science," no teacher can afford to miss.

G. W. W.

Dynamic Chemistry, by Harry C. Biddle, Head of Science Department, Glenville High School, Cleveland, and George L. Bush, formerly Head of Science Department, John Adams High School, Cleveland. Edited by William L. Connor, Superintendent of Schools, Allentown, Pennsylvania, formerly Chief, Bureau of Educational Research, Cleveland Public Schools. First Edition. Pp. x+820. 3.7×15×20.5 cm. Illustrated Cloth 1937. Rand McNally & Co.

A study of the declared purposes of the authors in presenting this new

high school chemistry text will show that they are as admirable as are the motives of the "New Deal" and perhaps as difficult of attainment. At any rate it is well to "hitch one's wagon to a star" and at least try "to give the student a knowledge of chemistry adequate to his academic or vocational needs. To help the student develop a scientific attitude that will carry over into all fields of thinking and, To give him an understanding and appreciation of the relation of chemistry to other subjects and to the world about him."

The title "Dynamic" was chosen because it is hoped that the use of the text will result in live relation of the subject matter to the student's life, will cause him to develop broad understandings and organize his knowledge and apply it to new situations.

The organization of the book is of the "unit" type with twelve major units. There are many excellent illustrations which perhaps will do as much as any one thing to help relate the work to the daily life of the student. A rapid study of the method of teaching such essential things as the use of the Avogadro law in deriving molecular weights shows that this type of work is well taught. There is an immense amount of descriptive chemistry presented so that the problem of the teacher who wants to be thorough is to select the essential parts of the book required for the giving of a course in general chemistry omitting much of the inorganic chemistry. This of course can be done. A goodly space is devoted to general organic chemistry and some of its applications. High school teachers of chemistry should want to look this new text over even if not now contemplating a change in texts in order to keep aware of the trend toward putting the social aspects of the teaching of science to the fore.

FRANK B. WADE

Mathematics and Life. by G. M. Ruch, F. B. Knight and J. W. Studebaker. 1937. Cloth. 480 pages. Scott, Foresman & Company, Chicago, Atlanta, Dallas, and New York. Book I.

This book is the first unit of a series of three for the Junior High School grades. The authors point of view in the writing of this book is consistently that of social mathematics, or in other words "Consumer Mathematics."

From the preface, the two major objectives of the "Mathematics and Life" series are:

1. The unification and socialization of mathematics.
2. The development of insight into and understanding of the mathematical principles presented.

A glance at the contents will give an idea as to the scope of the book:

1. The home and Mathematics (an overview).
2. Earning a living for the family.
3. Managing the family's money.
4. Taking care of the family's savings.
5. Using business methods in the home.
6. Improving the family's surroundings.
7. Working in the home.
8. A round-up of the year's work.

Outstanding features of the book are:

1. Quick drills.
2. Practice problems.
3. Self-testing drills.
4. Problem scales (tests).
5. Problem solving (verbal).
6. Problems for careful readers.

7. Side trips in Mathematics.
8. Chapter summaries.
9. Inventory tests.
10. Self-help practice and diagnostic tests.
11. Progress charts.

In addition, the book contains tables of measures and abbreviations, mathematical terms and an index.

Teachers of Mathematics are familiar with the work of the authors in their "Standard Service Series of Mathematics," and they will welcome this new series for the Junior High School.

HYMEN D. SILVERMAN

Useful Mathematics, A high-school course in fundamentals, by Flora M. Dunn, M.A., Head of the Mathematics Department, Fairfax High School, Los Angeles, California; Emmy Huebner Allen, M.A., Teacher of Mathematics, Fairfax High School, Los Angeles, California; John S. Goldthwaite, A.B., Chairman of Mathematics Department, Lincoln High School, Los Angeles, California; Mary A. Potter, M.A., Supervisor of Mathematics, Racine, Wisconsin. Copyright 1937 Cloth x+422 pages. Ginn & Company. Boston, New York, Chicago, London, Atlanta, Dallas, Columbus, San Francisco. Price $1.32.

This book, the result of extensive experimentation and teaching, is a revision of the authors' "Ninth Grade Mathematics," published in 1929, the title being changed to the present, "Useful Mathematics." The authors constantly kept in mind the capabilities and limitations of the pupils that constitute the classes of Mathematics.

The following features of the book are worthy of consideration:

1. The motivation of each topic.
2. The use of computational arithmetic, involving whole numbers, common fractions, decimal fractions and percentage.
3. The accuracy and checking of each problem is emphasized.
4. The extensive and colorful use of illustrations.
5. The Algebra used is based on the equation and the formula.
6. The use of intuitional geometry involving the appreciation of geometric figures, the construction and the solution of many problems.
7. An abundance of problems, graded to meet the needs of individual differences.
8. A summary at the end of each chapter which provides a convenient procedure of retaining the essential facts learned.
9. Tests are placed at the end of each chapter.
10. The Problems and situations are taken from life situations, business, shops and industry.
11. The use of arithmetic, algebra and geometry at the psychological moment.
12. The use of . . . everyday conversational style in preference to the traditional formal vocabulary of mathematics.
13. A suggestive arrangement of topics for two semesters' work.
14. A chapter of supplementary work which includes problems on electricity, lumber measure, and machines.
15. The book is attractively bound, the print is large, and each page invites the attention of the pupil.

The appendix contains various tables, formulas, and a "key to the sounds." An index follows the appendix.

Teachers of Mathematics will find this book the answer to the perplexing

problem facing us . . . "What shall we teach the pupils who do not care for Mathematics?"

HYMEN D. SILVERMAN

Plane Trigonometry, by Edward S. Allen, Associate Professor of Mathematics, Iowa State College, Ames, Iowa. Cloth. Pages xii+156. McGraw-Hill Book Company, Inc. 1936.

This is an informal text which presents the usual subject matter. The author is opposed to the use of cartesian coordinates hence he uses the leg opposite the vertex, the leg adjacent to the vertex, and the hypotenuse along with his own special definitions to define trigonometric functions. The book bears evidence of much labor. The approach is in general, analytic. It contains a number of good problems. Included are the very popular McGraw-Hill Tables.

JOHN J. CORLISS

Trigonometry by John W. Bronson, Professor of Mathematics, New Mexico State College of Agriculture and Mechanic Arts and J. O. Hassler, Professor of Mathematics and Astronomy, University of Oklahoma. Cloth. Pages viii+198. 1937. Henry Holt and Company, New York. Price with Tables $1.75; without Tables $1.50, Tables separately $.45.

This text presents the usual subject matter of Trigonometry with a brief introduction to the Spherical Trigonometry in language which the average college freshman of today can understand. The emphasis is on the subject itself. The applications are introduced by means of problems.

The approach is in general inductive and throughout the book the student is encouraged to think through and understand the process involved rather than to memorize the formula and blindly use it whether it applies or not. After every new idea is introduced, a number of exercises are given to thoroughly fix it in the mind of the student.

An outline of algebra with exercises for drill needed in trigonometry is given in the appendix.

The formula for the solution of oblique triangles are in the main derived analytically. The six trigonometric functions are first defined for an acute angle and later generalized. Logarithms are introduced in Chapter II. This is a distinct improvement over the order followed in many texts. Answers are given to the odd numbered exercises.

This text seems to be well written and very teachable.

JOHN J. CORLISS

ILLITE

Illite, a mica-like mineral, resembling ordinary mica, but occurring in sedimentary rocks, is announced as a new mineral by Drs. R. E. Grim, R. H. Bray, and W. F. Bradley, of the Illinois Geological Survey, reporting in The American Mineralogist.

Long mistaken for other minerals which it resembles, Illite has been called mica, sericite, hydromica, and glimmerton. Now, as a result of an exhaustive study, in which an X-ray determination of the crystalline structure was made, Illite is found to be a new mineral.

Illite is a common constituent of many shales, silts and sandstones. Its discovery may lead to a better understanding of the causes of the formation of mica in old sediments after they have been heated and compressed.

OKLAHOMA ACADEMY OF SCIENCE

At the annual meeting of the Oklahoma Academy of Science held December 3–4, 1937 at the University of Oklahoma, Norman, Oklahoma the following officers were elected:

Dr. C. M. Perry, Professor of Philosophy, University of Oklahoma—Pres.

Dr. Fenton, Entomology, A. and M. College, Stillwater—V. Pres. Sect. A.

Dr. O. F. Evans, Professor of Geology, University of Oklahoma—V. Pres. B

Dr. J. E. Webster, Dept. of Chemistry, A. and M. College, Stillwater V. Pres. Sect. C

Dr. G. M. Rankin, Edmond (Central State Teachers College) V. Pres. D.

Dr. George L. Cross, Dept. Botany, University of Oklahoma, Continued Sec.-Treasurer.

Dr. H. I. Featherly, Dept. Botany, A. and M. College, Stillwater Ass't. Sec.-Treasurer.

One *Fellow* of the Academy was elected:

Miss Edith R. Force, Science, Wilson Junior High School, Tulsa

This was in recognition of her work as Director of the High School Relations Committee and Chairman of the Association of Science Students of the Oklahoma Academy of Science.

The *Honorary Officers* of the Oklahoma Junior Academy of Science

President—L. D. Alley, Enid: Taxidermy Club—M. M. Boyer, Sponsor

Vice-President—Ruth Schultz, Norman: Norman High School Academy of Science—Clyde Fleming, Sponsor.

Secretary—Dorothy Jean Wilson, Enid: Luther Burbank Flower and Garden Club—M. M. Boyer, Sponsor.

Treasurer—Norbert Luecke, Okeene: Mendel Club—Sister M. Marion, Sponsor.

The Association of Science Students of the Oklahoma Academy of Science has become an independent organization called The Oklahoma Junior Academy of Science. The sponsors and Regional Chairmen who have acted in that capacity will continue, with a few changes, to carry on the work as has been done so progressively for the last three years. Any interested High School teacher and organized club is invited to make inquiry of the Chairman of the Junior Academy Committee Miss Edith R. Force, 3021 E. 8th Street, Tulsa, Oklahoma or of the *Regional Chairmen in each District:*

Northern District: M. M. Boyer, Senior High School, Enid.

Northwest District: Hugo Olsen, Carmen High School, Carmen.

Northeast District: G. E. Tenney, Cleveland Junior High, Tulsa.

Southeast District: Auval Brown, High School, McAlester.

Central District: Mildred Parker and Beulah Zimmerman, High School, Drumright.

Southwest District: Eunice Cormack, High School, Lawton.

Eastcentral District: Henry Hooper, Wewoka High School, Wewoka.

The insignia of the Oklahoma Junior Academy of Science will be that adopted by the national organization, a pin the shape of the state of Oklahoma, with the words Junior Academy of Science in gold on a blue background. The guard is the Greek Amorpha the symbol of abundance.

WATER POWER

Norway has the greatest available water power in proportion to population of any country in the world.